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Soviet Geography: Review and Translation

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TRANSLITERATION TABLE

Russian			English	Russian			English
А	а	*а*	a	Р	р	*р*	r
Б	б	*б*	b	С	с	*с*	s
В	в	*в*	v	Т	т	*т*	t
Г	г	*г*	g	У	у	*у*	u
Д	д	*д*	d	Ф	ф	*ф*	f
Е	е	*е*	e*	Х	х	*х*	kh
Ж	ж	*ж*	zh	Ц	ц	*ц*	ts
З	з	*з*	z	Ч	ч	*ч*	ch
И	и	*и*	i	Ш	ш	*ш*	sh
Й	й	*й*	y	Щ	щ	*щ*	shch
К	к	*к*	k	Ъ	ъ	*ъ*	"
Л	л	*л*	l	Ы	ы	*ы*	y
М	м	*м*	m	Ь	ь	*ь*	'
Н	н	*н*	n	Э	э	*э*	e
О	о	*о*	o	Ю	ю	*ю*	yu
П	п	*п*	p	Я	я	*я*	ya

(*) Instead of e, use ye at the beginning of names, after vowels and after the soft sign (').

The transliteration table is supplied for the general information of readers and to enable them to identify the geographic names on maps that will be reproduced from time to time in SOVIET GEOGRAPHY.

The transliteration system is the one proposed by the United States Board on Geographic Names. For more general use in textbooks and other popular needs, the following simplifications are recommended by the editor of SOVIET GEOGRAPHY:

1. Eliminate the use of (') and (").
2. Use i for iy, and y for yy.
3. Convert diphthongs ay, ey, oy, uy to ai, ei, oi, ui.

THE THIRD CONGRESS OF THE GEOGRAPHICAL SOCIETY OF THE USSR

THE HEAT AND WATER BALANCE OF THE EARTH'S SURFACE, THE GENERAL THEORY OF PHYSICAL GEOGRAPHY AND THE PROBLEM OF THE TRANSFORMATION OF NATURE

By M. I. Budyko and I.P. Gerasimov

Our times are characterized by an unusually rapid development of the sciences and an extraordinarily complex differentiation of them. In this process two main tendencies manifest themselves with special clarity:

(a) the breakup of the old "great" sciences into many narrower and more specialized scientific disciplines;

(b) the development of many new sciences on the borderlines dividing the branches that are being differentiated.

The breakup of the great old sciences into numerous narrow and specialized scientific disciplines is the consequence of the general progress of scientific knowledge and its ever increasing depth. The development of many new sciences on the borderlines of the branches being differentiated is due to the necessity of preserving the unifying threads between sciences, for the scientific front as a whole must always be continuous. However, these unifying threads often prove inadequate. In such cases there must arise on certain sectors of the rapidly expanding front of the natural sciences additional ties that penetrate into the centers of the various series of scientific disciplines and form solid supports in the complex intertexture of the various branches of natural science.

It is such a responsible role that, in our opinion, the problem of the heat and water regime of the earth's surface, discussed in the present symposium, is destined to play a major part in the rather extensive series of geographical and geophysical sciences. Let us deal with this question in somewhat greater detail.

It is known that in the system of geographical sciences proper, the investigations in the field of earth science, or regional geography, have thus far carried the most weight in the mutual relations and unification of those sciences. Having the task of generalizing the diverse accumulated scientific geographic data from the regional viewpoint, these classic trends of geographic work are, as is known, the oldest and most consecrated by long tradition.

This tradition was founded on certain practical requirements made upon geographic science, which was called upon to satisfy the cultural, economic and technical demands for knowledge of various countries and territories. Here it should be emphasized that the consolidation of diverse information on the natural conditions and resources of countries and territories, effected by earth science or physical geography, has long been founded, at least since Humboldt's time, upon the study of the mutual relations between natural

phenomena. Depending upon the level of development of the general theory, and of the methods of study and the practical problems, the depth of the scientific analysis of such relations between natural phenomena has differed in different stages of the development of physical geography. For a long time, physical geography contented itself with a rather superficial investigation of such interrelations, using chiefly descriptive methods for this purpose, taking note of this or that correlative dependence and writing qualitative characterizations of the laws observed. As a result, physical geography produced in the main only primitive, non-intensive methods of exploiting natural resources.

However, it must be clearly understood that modern geography is not a science of the 18th and 19th centuries, but a science of the present 20th century. It cannot remain a descriptive-perceptual science, having unexplored lands as its object, and its chief practical task is no longer scientific aid in developing virgin territories. Modern geography must have an experimental-transformative trend, having as its main object long since discovered countries and lands, developed by man and possessing a greatly altered physical environment. For this reason, the chief task of modern geography is all-around scientific service to the great work of mankind in the manifold and ever more intensive utilization of known natural resources and the transformation of the nature of settled territories.

In this connection, the present stage in the development of the geographic sciences, linked with the solution of new and complex practical problems, requires for their successful resolution a considerable raising of the general theoretical level of scientific research, aimed at the study of the mutual relations between natural phenomena, and a great expansion of the range of research methods. One of the effective ways of achieving these purposes in physical geography is, in our opinion, the working out of the scientific problem of the heat and water regime of the earth's surface. This problem (its full title is: The heat and water regime of the earth's surface, its role in the dynamics of the natural processes, the geographic differences and methods of transformation for practical purposes) belongs to the most important problems of the coordinating plan of scientific work of the Academy of Sciences of the USSR.

The main scientific idea underlying the problem under discussion is that the heat and water balance of the earth's surface in the natural geographic environment is, as a rule, the main mechanism that determines the intensity and character of all the other forms of exchange of energy and matter between the basic components of the geographic environment, i.e., the climatic, hydrologic, soil-forming, biologic and other phenomena occurring on the earth's surface. Moreover, it must be considered that the various spatial variations of the heat and water balances of the earth's surface, due to general or local factors, largely govern the diverse geographic modifications in the character of that exchange. Therefore, by studying the mechanism of the exchange of heat and moisture and purposefully acting upon it with the aid of various natural or artificial measures, it is possible to bring about

premeditated and stable transformations in the course of the manifold natural processes and phenomena on the earth's surface. If we have in mind the achievement of certain practical results in the interest, for example, of construction, water, agricultural or forest management, as well as public health, which are connected in many ways with natural phenomena and processes, such premeditated transformative measures may be called natural heat and water ameliorations (transformations). In this case the essence of the problem under discussion can be very briefly defined as follows: the study of the natural heat and water balance of the earth's surface, the determination of its role in natural geographic phenomena and the working out of methods for purposeful change are the scientific foundation for the development of the theory and practice of the main types of natural heat and water ameliorations, i.e., the problems of the transformation of nature.

Thus, the proposal of the problem of the heat and water regime of the earth's surface for working out methods for its purposeful transformation has the object of widening the research work in the development of the scientific theory of various ameliorative measures aimed at transforming the natural conditions in the interest of the national economy.

After this brief introduction regarding the theoretical and practical significance of the problem under discussion, let us turn to an examination of its present state.

The first steps in the study of the characteristics of the heat and water regime of the earth's surface were taken in the 18th century, when observations of the air temperature and precipitation were commenced in accordance with a uniform program at meteorological stations situated at various points of the earth's surface. From the middle of the 19th century, such observations assumed a mass character due to the rise and rapid development of a worldwide network of hydrometeorological stations. In the course of this development the program of observations of the indices of the heat and water balance gradually expanded, embracing more hydrometeorological elements.

Beginning with the end of the 19th century, observations of the regime of solar radiation were organized at a number of meteorological stations. At about the same time, systematic measurements of stream flow and evaporation from the land and bodies of water were begun in various countries. Later, such observations were the immediate basis for the experimental study of the heat and water balances of the earth's surface.

In the 20th century the first small number of actinometric stations gradually expanded into a worldwide actinometric network, embracing whole continents, including Antarctica. In recent years, observations of such components of the heat balance as the loss of heat through evaporation and the turbulent heat exchange between the earth's surface with the atmosphere were first organized at meteorological stations in the USSR.

Beside observations at meteorological stations, detailed data on the

radiation and heat balance of the earth's surface were obtained in a large number of research expeditions made in various regions with diverse climatic conditions.

In addition to observations of the components of the heat balance, there are now numerous stations at which the components of the water balance are also observed.

It should be pointed out that observations of the various components of the water balance are still at different levels of perfection. Data are most extensive for atmospheric precipitation, which has been observed for a long time at stations covering virtually the whole land surface except for a few remote regions. In second place in this respect are observations of stream flow, measured with rather high accuracy at many hydrologic stations. It should be noted, however, that hydrologic stations are unevenly distributed over the earth's surface. While observations of stream flow are now made at thousands of stations in the USSR, no such observations are made in many extensive areas of less developed countries.

The situation is considerably worse with regard to observations of evaporation. In the Soviet Union such observations are carried out at dozens of stations, whereas in most foreign countries measurements of evaporation values are not carried out on a really mass scale.

Comparatively few observations are likewise being made of the moisture circulation in the upper layers of the soil. Mass observations of the humidity of the upper layers of the soil are now being made only in the USSR, where they are organized in a network of agrometeorological stations. Although these observations are made mainly in agricultural areas and therefore do not characterize the conditions of all the natural zones, they still yield a general idea of the water balance of the soil in many regions.

It should be noted that observations of the indices of the heat and water balance of the earth's surface made on the oceans differ sharply in scope and quality from those made on land. The data on atmospheric precipitation for the larger part of the oceanic areas are not sufficiently reliable. Systematic observations of the indices of solar radiation over the oceans have only recently commenced, and there are no really mass observation data for most of the components of the heat and water balance.

For this reason, and also in consideration of the fact that data on the systematic measurements of most of the components of the heat and water balances are lacking for the larger part of the land surface, methods of indirect calculation are now widely used in studying the geographic laws of the heat and water balance.

The application of such methods has made it possible to construct a whole series of world maps of the distribution of the components of the heat and water balance of the earth's surface.

In particular, a series of world maps of total solar radiation, the radiation balance of the earth's surface, the losses of heat through evaporation and turbulent heat exchange have been constructed by the Main Geophysical Observatory named for A. I. Voyeykov.

In research on the water balance of the land, it was found possible to construct world maps of only one component of the balances, namely precipitation, as a result of direct generalization of the observation data. To construct world maps of runoff and evaporation, methods of indirect climatological computations had to be widely used.

The development of meteorological and hydrologic observations of the indices of the heat and water balance, along with the application of special computation methods, has contributed to the accumulation of data on the heat and water balance of the earth's surface. As pointed out above, these data already furnish an important basis for working out many interrelated questions of the meteorological and hydrologic sciences, and have substantial significance for studying a number of general problems of physical geography.

Let us dwell briefly upon the principal trends of research connected with the use of data on the heat and water balances.

In meteorology and climatology, there has lately been a considerable expansion of the application of information on the heat and water balance to the clarification of the laws governing the processes under study. In particular, data on the heat and water balance are widely used in climatic research in working out the general questions of the theory of climate, in studying the moisture circulation in the atmosphere and in the comparative analysis of the climate of various territories. In work on dynamic meteorology the equation of the heat balance is used in investigating the daily march of the meteorological elements, the local circulations of the atmosphere, in calculations of the transformation of air masses, etc.

Data on the heat and water balance are also employed in solving many problems of agrometeorology and other meteorological disciplines.

In work on the hydrology of the land, data on the heat balance are employed in calculations and forecasts of snow thaw, in the study of the thermal regime of bodies of water, the hydrologic regime of swamps, and so forth. The possibility has recently been brought out of using data on the heat balance of the land in determining the mean magnitudes of runoff and evaporation from the land. There is no need to mention here the application of the water-balance method in hydrology of the land, inasmuch as this method is the basic one in working out most of the problems of this discipline.

In oceanographic research connected with the study of the hydrometeorological regime of the seas and oceans, calculations of the heat balance are used in studying the laws governing the regime of currents, salinity,

evaporation, and so forth. Recently attempts have been made to apply data on the heat balance of oceans to working out methods of hydrometeorological forecasting.

It should be noted that the use of data on the heat and water balance in the hydrometeorological sciences has resulted recently in bringing meteorology and hydrology considerably closer together, i.e., in strengthening and broadening the bonds that unite these geographic disciplines. This rapprochement reflects the unity of the processes of heat exchange and moisture exchange in the whole natural geographic environment, including the atmosphere, the hydrosphere and the upper layers of the lithosphere. The overcoming of the historically constituted split between the hydrometeorological sciences in the study of the heat and water balance contributes to their successful development, especially on the way toward the solution of such important integrated problems as the interaction between the atmosphere and the oceans, the heat exchange between the oceans and the land, the moisture circulation and many others.

It should be stated that a similar rapprochement has begun to appear very recently in the biogeographic sciences. In this field there is a rapid development, on the basis of station observations, of new scientific trends in soil science, geobotany and zoogeography, designed to study the dynamics and rhythm of the respective natural processes on the basis of hydrothermal factors of soil formation and biologic productivity.

Of special significance is the question of the employment of data on the heat and water regime in the study of the general problems of physical geography.

As already noted, beginning with the end of the 19th century, physical geography gradually became differentiated to an ever increasing degree and turned into a complex of particular geographic sciences. The differentiation of geographic research has, generally speaking, been useful because it has contributed to the rapid accumulation of empiric data, and helped to develop new methods of research, connected in a number of cases with the wide employment of data of the physical-mathematical disciplines (particularly in the hydrometeorological sciences). However, the independent development of the particular geographic sciences has also resulted in their isolation and has produced difficulties because of the need to generalize the data of the various divisions of physical geography for the solution of specific problems.

In the middle of the 1930's, the work of A. A. Grigor'yev raised the question of creating a method for investigating the general physical-geographic laws suitable for studying the whole complex of interrelated processes developing in the external geographic envelope. A. A. Grigor'yev proposed that this method be based on an investigation of the characteristics of the systems of the balances of matter and energy for each typical physical-geographic province (zone). In so doing, he noted the significance of the balance of radiant energy and the moisture balance as factors determining the dynamics of the whole complex of the natural surface processes.

It should be noted that Grigor'yev's basic ideas were formulated before the time when mass data had been obtained on the geographic distribution of the components of the heat and water balances of the globe. This caused certain difficulties in the development of these ideas in specific investigations. Nevertheless, Grigor'yev was able to obtain important results in the study of the general geographic laws.

Grigor'yev's ideas had considerable influence upon the development of the study of the heat and water balance of the earth's surface. In particular, the above-mentioned work on the heat and water balances of the earth's surface was organized in the mid-forties at the Main Geophysical Observatory in direct conjunction with Grigor'yev's investigations.

In subsequent work by A. A. Grigor'yev and other authors, data on the heat and water balance were used for the study of the connections between hydrometeorological factors and various geographic processes. Special attention was paid to the study of the conditions affecting the intensity of the natural biologic processes and, in particular, those determining the level of productivity of the natural plant cover.

The general laws of geographic zonality were also investigated. As noted earlier, the Presidium of the Academy of Sciences of the USSR in 1954 included among the most important problems of Soviet science that of "the heat and water regime of the earth's surface, its role in the dynamics of the natural processes and methods of transformation for practical purposes."

The work programs set up for this problem by a team of specialists were published in 1956 and 1958.

In the spring of 1959, a conference was held in Leningrad, which summed up the work on this problem and drafted the tasks for further research. A resolution adopted by this conference pointed out that the working out of the problem of the heat and water regime of the earth's surface has great significance for the development of the theory of physical geography revealing the genetic unity of the natural geographic environment, uniting the whole system of geographic scientific disciplines and making it possible to pass from descriptive methods of the study of the geographic environment to more precise, quantitative methods revealing the physical nature of the interaction between the various processes and phenomena. The conference also noted the practical significance of working out the long-term problem of a more efficient utilization of the natural heat and moisture resources of the Soviet Union, and of supplying a scientific basis for the various measures for transforming nature in the interest of the national economy.

The papers of our symposium set forth in detail the results of the latest research in the main divisions of the work program discussed above. For this reason, we will not examine the results here, but will only dwell on one question, which, it seems to us, has an essential fundamental significance - the question of taking into account the data on the heat and water balance in justifying the measures for the transformation of nature.

We know that many measures widely applied in the national economy have the object of changing the conditions of the water or the heat regime. Among such measures are the various methods of irrigation and drainage, windbreak plantings, various methods of protecting plants from frosts and others.

In order to estimate in advance the hydrometeorological effectiveness of these measures and to plan them most suitably, it is necessary to study in detail the physical mechanism of the effect of the measures to be executed upon the water and heat regime.

Recently a number of scientific institutions have carried on a series of investigations on this problem. It has been established that the data on the heat and water balance make it possible to explain many laws of the change of the water-heat regime through reclamation. For this reason, these data have essential significance for the planning of reclamation measures.

In particular, estimates of the heat balance make it possible to determine rational irrigation norms and to evaluate the effect of irrigation upon the meteorological regime of the air layer near the ground. Investigations of the heat and water balances of the earth's surface have made it possible to work out the physical theory of the hydrometeorological efficiency of windbreak plantings. The conclusions drawn from this theory have been used as a basis for the most suitable designs of shelter belts under various climatic conditions.

The planning of reclamation measures in areas of excess moisture also involves the utilization of data on the heat and water balances.

In particular, the planning of swamp drainage is done on the basis of estimates of the water balance, the information on the heat balance being used both to determine the evaporation from the swamps and to evaluate the effect of drainage upon the meteorologic regime of the air layer near the ground. Observations of the heat balance are used to ascertain the effect of plantings of tall shelter crops on the thermal regime in regions with a heat deficit, to evaluate the effectiveness of the various methods of protecting plants from frosts and to solve a number of similar agrometeorological questions. Of special significance are the materials on the heat balance for estimates of the effectiveness of measures for thawing out frozen subsoil.

The basic principles of rational control of droughts and soil erosion by the study and regulation of the water balance of a territory to be reclaimed were already formulated in the famous work of V. V. Dokuchayev on the nature of the steppes. In subsequent work by Russian scholars, these principles have received full confirmation and further development.

Without dwelling upon many other problems of local changes in the natural conditions, whose treatment requires the employment of data on the heat and water balance, let us note that it is now possible to pose the question of planning measures for changing natural conditions on a broad scale, involving vigorous actions upon the climate and hydrologic regime of large territories.

The rapid development of modern technology and the immense expansion of power resources open up new possibilities of carrying out far-reaching measures capable of profoundly transforming the nature of the Soviet Union. However, the planning of such measures requires an accurate knowledge and detailed consideration of the conditions of the heat energy and water balances of the territories to be transformed.

As is known, the greatest changes in the natural conditions achieved in recent years are due to the realization of hydrotechnical construction projects. As a result of the realization of these plans and the creation of a number of large reservoirs, the microclimatic conditions have been noticeably changed, including the regime of the temperature and moisture of the air, of evaporation, of the wind, and so forth.

Methods involving the water and heat balances of the earth's surface have been widely used both to estimate the hydrologic regime of reservoirs and to evaluate their effect on meteorological conditions.

It may be supposed that in the near furture measures changing not only the climate of the ground layer of the air, but also the general climatic conditions of vast areas will prove to be entirely realistic.

For example, the question is now being discussed of the artificial augmentation of the amount of precipitation in areas with insufficient moisture with the aid of special reagents seeded in the air. To evaluate the effectiveness of such measures, it is necessary to make detailed estimates of the water balance of the earth's surface and the atmosphere. The considerable progress made in recent years in the investigation of the moisture circulation permits the hope that such estimates can be made with the necessary accuracy.

Among other questions relating to the problem of changing natural conditions may be mentioned those of the possibility of acting upon the glaciers and ice cap of the Arctic Ocean, a question that has long interested specialists, radical transformations in the distribution of the river network, of ocean currents, and so forth.

Although the available energy capabilities are for the time being still insufficient to carry out projects of that sort, it may be assumed that with rapid progress in the field of development of atomic energy, projects on such a scale will soon be realizable. Such projects are largely based on estimates of the heat balance of the object under study in the existing state and in the presence of a given artificial action.

It should be noted that many proposals have been advanced in recent years regarding ways of changing the climatic conditions over extensive territories through the realization of special-purpose reclamation measures. Unfortunately, such proposals have usually been worked out without taking proper account of the laws of the heat and water balances, which rob them of practical significance. It is evident that any project for transforming the hydrometeorolgical

regime of large regions can be created only on the basis of a detailed study of the processes of the heat and moisture exchange, with full utilization of all the information on these questions that is available from modern research.

In conclusion, we wish to touch once again on the question of the prospects of developing investigations of the heat and water balances in physical geography. As noted above, these investigations now occupy a large place in the particular geographic sciences and are being made for the solution of theoretical and practical problems. It may be supposed that, along with the further development of the use of methods involving the heat and water balances in the particular geographic disciplines, these methods will find considerably wider employment in working out the general problems of physical geography involving the study of integrated geographic phenomena and processes.

Progress in this direction will, on the one hand, contribute to bringing the particular geographic disciplines closer together and, on the other hand, aid in the gradual conversion of physical geography from a largely descriptive science into a science using accurate and modern methods of research suited to the thorough study and ascertainment of the physical essence of the diverse natural phenomena and their mutual relationships.

MOISTURE CIRCULATION AND ITS ROLE IN NATURAL PROCESSES

By O. A. Drozdov

The role of water and its circulation in nature is generally known. The moisture circulation between the oceans and the land is the basis for the formation of water bodies on the land and the supply of moisture to the soil and subsoil. As one of the important components of the exchange of matter in nature, water acquires special significance in the exchange between living nature and the abiotic environment, without which organic life is essentially impossible. Moreover, among all the elements of nature, water performs the greatest migrations in the process of exchange, moving over huge distances in the atmosphere, hydrosphere and in the ground. Even the mobility of the gaseous components of the exchange of matter, particularly oxygen and carbon dioxide, because of their lack of phase transformations, is inferior to water not only in diversity, but also in speed of movement, for example in the ground or in the oceans in cases where gases are not transferred together with water in the form of solutions. No less important is the role of water and its circulation in the exchange of energy in the geographic envelope of the earth. It is known, on the basis of M. I. Budyko's work, that a large part of the energy of the atmospheric circulation is transferred in the form of the latent heat of evaporation. The distribution of moisture and cloudiness in the atmosphere substantially changes the radiation regime at the earth's surface and the radiation balance of the active surface. Connected with the energy of the water received in the process of moisture circulation is the work of water on the earth's surface: changes in the form of the relief, erosion of

shores, leaching of the ground, transfer of salts in the ground and in the atmosphere, water erosion, and so forth.

Thus, water, in the process of circulation over the globe, is one of the most important components of the exchange of matter and energy in the geographic envelope of the earth. It is natural that the role of water should be extraordinarily great both in the process of formation of natural landscapes, and in their change due to the spontaneous or deliberate activity of human society, for instance in the process of agricultural production. But water can also serve as an impediment to production, when it is present in excess and hampers, for example, the development of soils, lowers the yield of farm crops, obstructs transportation, and so forth.

Despite the immense role of water in the various natural processes and in man's own productive activity, we do not yet have a sufficiently clear concept of the natural processes involved in the circulation of water. This applies especially to the moisture circulation of the atmosphere, where until recently there was not even a correct conception of the scale of the advection of water vapor from the oceans to the land. It has now been established that, although algebraically the flow of moisture from the oceans to the land is numerically equal to the runoff, this advection of water vapor over the land in temperate latitudes exceeds the amount of precipitation. This excess probably amounts to 10-20% for Europe, and 35% for North America. Part of the moisture must pass across the whole continent and be carried out back to the ocean, even if one does not take into account the water vapor coming into the atmosphere from local evaporation. The amount of moisture carried in the atmosphere, even for continents as a whole, exceeds by 1 1/2 to 2 times the amount of vapor entering the atmosphere as a result of local evaporation. This has caused a radical revision of the views, existing some ten years ago, regarding the multiple moisture cycle over a continent, expressed at one time by E. Brückner and N. N. Kasatkin before the beginning of systematic aerologic observations. Similar views continued to exist, especially among hydrologists, even when the quantitative side of the atmospheric circulation of moisture had been defined more precisely through the development of radio sounding. Aerologic observations fixed the relatively great speeds of transfer of moisture over the continent, by virtue of which the air passes in only about 10 days through the temperate latitudes of Eurasia. This shows the magnitude of the amount of moisture exchanged between land and ocean. Aerologic data also make it possible to compile maps of the distribution of moisture in the atmosphere. The maps in turn point to certain geographic laws of the distribution of atmospheric humidity. In particular, the moisture content of the atmosphere in the high altitudes of tropical monsoon areas is approximately twice as large as the summer magnitudes in temperate latitudes. Inasmuch as the velocities of the wind currents in the monsoon regions are just as high as those in the temperate latitudes, it may be concluded that the amount of moisture moving from the ocean to the continents in the tropical latitudes, as well as from the land to the ocean, is also about twice as great as the flow of moisture in temperature latitudes.

The greatest bottleneck in the quantitative determination of the transfers of moisture is now the inadequacy of aerologic methods of recording moisture, especially at great altitudes; to a lesser degree that of the aerologic methods of recording winds; data are almost entirely lacking on the amount of moisture carried in clouds.

While until recently estimates of the moisture circulation of large territories were made theoretically and sometimes provoked disputes, it is now possible to make direct estimates. Thus, S. I. Zhakov has made a detailed study of the air masses providing the humidity for the formation of precipitation over the European territory of the USSR. In spite of certain inevitable inaccuracies in the methods of such labor-consuming research, the results obtained are in close agreement with the theory worked out earlier. Begeman and Libby in 1957 estimated the amount of local and oceanic vapor participating in the formation of precipitation over the basin of the upper Mississippi from a comparison of the isotope composition of the precipitation in that region with the isotope composition of river runoff and ocean water. As a result of the thermonuclear tests all these waters have been found to be enriched with tritium to various degrees, and from the tritium content in the precipitation it has been possible to judge the proportion of vapor of continental and oceanic origin contained in it. The authors have come to the conclusion that in the region under consideration the precipitation from continental vapor amounts to one-third of the total precipitation, which agrees in general with the data from investigation of the moisture circulation by earlier American authors (Holzman and Thornthwaite, Benton, Astock and Dominick).

Comparing these results with the theory of moisture circulation developed in the USSR by Kh. P. Pogosyan, K. I. Kashin, M. I. Budyko, O. A. Drozdov, A. I. Burtsev and others, it is evident that the proportion of local vapor in the formation of precipitation is smaller than it was considered to be in the estimates of the Soviet authors. Possibly one of the reasons for this is the underestimation of the advection of water from the ocean because of the failure to take account of the moisture content of the drops in clouds. At the same time, the work of Soviet authors by no means denies the great role of evaporation from the continents in the formation of precipitation from vapor of mixed origin. In particular, the present author's work has established the significance, in the formation of precipitation, not only of the moisture content due to temperature, but also of the relative humidity, which the evaporation from the continent maintains at a level permitting the formation of precipitation; in the absence of evaporation the inner parts of the continents would become deserts. These factors are especially important in the formation of the precipitation regime of a given territory over a period of years when the prevailing character of the atmospheric circulation permits the formation of precipitation. It is understandable that in the anticyclone areas, particularly in the trade-wind deserts, the role of circulation comes to the fore as a cause of dryness, but here it at the same time sharply reduces the moisture content as well (by about twice compared with the surrounding regions) and reduces the relative humidity all the more. When the weather anomalies of the temperate latitudes are taken into account, the atmospheric circulation

and the vertical movements caused by it are found to be the principal factor in the formation of precipitation. However, an analysis of catastrophic droughts shows that the hydrothermal characteristics of the atmosphere, though secondary, later exert an effect upon wetness or dryness that is only slightly inferior to the direct effect of the atmospheric circulation.

Finally, in the formation of individual rains, a substantial role is played, in addition to the above-mentioned factors, by the presence in the atmosphere of nuclei of condensation and definite admixtures promoting coagulation. Such, under natural conditions, are ice crystals. It should be borne in mind that this aspect of the question is very important for an evaluation of the effect of artificial action on precipitation, but for the formation of precipitation under natural conditions it has not yet been established whether this has any substantial significance either from a climatic or a weather point of view. Moreover, the very fact of the presence of condensation nuclei in the atmosphere is due to the transfer of salts in the atmosphere, from the ocean to the land and from some areas of land to others. This transfer, on the one hand, affects the chemistry of precipitation and, on the other, probably has great significance for the salt balance of the territory (Acad. A. A. Grigor'yev, V. F. Derpgol'ts). Unfortunately, few persons have thus far concerned themselves with these questions, and a network for a systematic recording of the chemistry of precipitation in the Soviet Union has only begun to be created in conjunction with the International Geophysical Year. In this respect we are for the time being behind certain Western European countries, where a great deal of attention is being paid to the chemistry of the atmosphere as a factor of climate.

The first research in the water balance concerned the active surface (more accurately, the system composed of the active surface and the subsoil). Among its elements, the systematic study of atmospheric precipitation began earlier than the others and there are now maps of its distribution, both for individual territories and for the whole world, and both for the year and for separate months. Late came the systematic study of river runoff. However, it is today often better known for large territories than is precipitation. Evaporation thus far remains the least studied, there still being no protracted series of reliable observations of it. Hence, the magnitudes of the evaporation from the land over a period of years are usually determined from the difference between precipitation and runoff and, over the oceans, on the basis of energy considerations. Inasmuch as the mean value of filtration into the soil over a period of many years can often be neglected, the general and zonal laws of the distribution of precipitation, evaporation and runoff are comparatively well known; but because of the absence of direct high-quality observations of evaporation and the amount of precipitation over the surface of the ocean it has not yet been possible to relate the data on precipitation and evaporation from the oceans to the water balance of the globe. The amount of precipitation measured by shore and island stations and observations of the frequency of precipitation over the oceans has been exaggerated, and the evaporation necessary to compensate for this precipitation does not correspond to the energy resources of the ocean surface. To be sure,

relatively recently this discrepancy has been eliminated in the compilation of Volume II of the Marine Atlas. In the compilation of the map of the radiation balance by M. I. Budyko and his associates it developed that the effect of cloudiness on solar radiation over the oceans had been overestimated, so that the total radiation was calculated too low. On the precipitation map the author carefully checked the places where the amount of precipitation might possibly be too high. Nevertheless, direct data for the oceans give lower precipitation values than those shown on that map.

It has thus far been possible only as a first approximation to balance long-term averages of precipitation, evaporation and runoff. It has been found that the average annual magnitude of precipitation and evaporation amounts to about 900 to 1000 mm. for the globe. The existence of great inaccuracies in the manner of recording each of the components of the water balance requires improvement of the measurement methods and the further development of balance research. There are still few measurements of precipitation over the sea, and indeed it is difficult to insure accuracy of measurement there. On land, the manner of recording winter precipitation is especially inaccurate; the unrecorded liquid precipitation amounts to 10-15% and no record is kept of horizontal precipitation (settlement of hoar-frost, ice coating, humidity of fogs, etc.), which has special significance in mountain localities. In the mountains, poor records are kept likewise of the vertical liquid precipitation because of the lack of coverage in the upper parts of the mountains. This results often in great discrepancies between precipitation and the water balance of a territory in mountainous, polar and very windy continental regions. The use of snow-survey data, though it improves the recording of winter precipitation in a number of cases, does not always yield reliable results and, what is most important, systematic observations of it have not been subjected to mass analysis even in the Soviet Union.

At the same time, the methods of estimating evaporation from the land, both by the weight method of evaporators and with the aid of direct measurement of soil humidity, causes great inaccuracies for various reasons.

Estimates of the evaporation by the heat-balance method and by the method of measuring the diffusion of vapor have certain deficiencies of their own, and, most important, although they have yielded valuable data under field conditions, they are still little used at stations and no extensive data have been accumulated. Determining evaporation from tall vegetation is especially complicated.

Empirical formulas for determining evaporation and evaporability (the maximum possible evaporation under given geographic conditions) by means of the deficit of air humidity and similar magnitudes can be employed only for conditions close to those under which these formulas were obtained, and their application in other geographic zones is found to be unreliable. Of great use not only in the general geographic sense, but also for recording and checking the elements of the water balance of the land surface has been

the theoretical work by M. I. Budyko on the determination of evaporability, using the relationship between the elements of the heat and water balance and the laws of evaporation in various environments. In particular, he has recently worked out a new direct method of determining evaporation from the active surface, applicable to comparatively short periods and apparently yielding more accurate results than B. V. Polyakov's empirical method and, what is most important, applicable under the most varied conditions. Among the earlier known empirical methods of determining evaporability in the temperate latitudes, that of G. T. Selyaninov, relating evaporability to the sum of temperatures, has proved the most reliable. N. N. Ivanov's method greatly exaggerates evaporability (from small bodies of water) under desert conditions and underrates it in the humid regions of the north. In questions of the measurement of runoff on the land there are likewise certain unclear questions, especially for small and slightly dissected basins. Certain difficulties arise in the determination of runoff under conditions of strongly developed invisible runoff (for example, if the beds of rivers are clogged with pebbles), in the presence of karst phenomena, and so forth.

Little account has thus far been taken of the subterranean flow of water entering the ocean directly below sea level. These questions have substantial significance for hydrogeology, but there are also assertions that the discharge of these waters may be so great as to alter our notions of the water balance of large land territories. If the discharge of these waters is really great, it must be assumed that the unrecorded precipitation in mountains amounts to substantially larger magnitudes than we now suppose, and indeed that even on the plains the precipitation is substantially under-recorded. Among the elements of the water balance of the solid envelope of the earth, soil moisture has the greatest practical significance. The methods of recording soil moisture are extremely labor-consuming and imperfect, which renders difficult the estimation of the water balance of the soil; the results of measurements accumulated by agrometeorological stations over a protracted period nevertheless yield material for climatological generalizations, and the work of S. A. Verigo and others is of great interest both for agriculture and for theoretical investigations of the water balance. A still more complex task is the determination of the water balance of the plants themselves, though the work of agronomists and agrometeorologists on the one hand, and of agrophysicists on the other, is gradually leading to a study of this question. This type of research requires a detailed recording of the water balance of the soil and of evaporation, the components of the balance most difficult to determine; nevertheless, there is already valuable work on the determination of the moisture circulation of cultivated plants under field conditions (A. M. Alpat'yev).

As a result of the research of the last decade, the moisture flow at various altitudes in the atmosphere is now known as a first approximation, and attempts are being made to evaluate the balance of humidity in the atmosphere over both large and comparatively small territories. Such work has been done for the European territory of the USSR, Britain, North America and Southeastern Asia. This task can be brought to a successful conclusion

only in cases where there are first-rate observations up to altitudes of the order of 7km. and detailed data are used on the profiles of distribution of moisture and wind in the lower layer, through which more than one-third of all humidity is conveyed (Hutching, 1953). There is information on the order of magnitude of the exchange of humidity between the continents of the northern hemisphere and the surrounding seas. Laws have been ascertained for the formation of precipitation as a function of updrafts, humidity resources in the atmosphere and the relative humidity of the atmosphere. The role of these factors is especially important in explaining the annual march of precipitation and the correct evaluation of the role of evaporation in the formation of precipitation. The effect of local evaporation on the formation of precipitation is practically nil when atmospheric humidities are lower than 40%; but it attains the highest values when the humidity is about 55 to 60%, corresponding to the conditions of the warm season of the year in the forest-steppe. When the humidity is high, the amount of precipitation produced in the presence of updrafts is approximately proportional to the moisture content of the atmosphere. Maps have been plotted showing the moisture content of the atmosphere of the northern hemisphere and revealing not only the effect of latitude (temperature) and the effect of the distribution of water and land, but also a large number of new and very important laws. In particular, it has been found out that the moisture content in the tropical monsoon regions is extraordinarily high (more than 50 mm.) and affects also the processes in near-by regions of the temperate latitudes. The effect of updrafts, both the dynamic ones and those due to relief and differences in roughness, on moisture content has also been found to be important. Thus, in the trade-wind areas of the deserts the moisture content on the land is reduced to about one-half of that of the surrounding regions. In the deserts outside the tropics (for example, in Central Asia) no such phenomena are observed. A considerable lowering of the humidity content in anticyclonic areas is also observed over the oceans, particularly in the western part of the Pacific. An opposite tendency arises in areas where updrafts predominate. This is apparently related to the high moisture content in summer over the coastal seas of Southeastern Asia and a rise in the moisture content in the western parts of the continents of the temperate latitudes, which cannot be explained by the action of evaporation, if only for the reason that the precipitation there often exceeds the evaporation.

Thus, the amount of moisture in the atmosphere depends substantially upon updrafts, and all three principal factors determining the amount of precipitation are in complex interaction with one another. The relationships between the moisture of the atmosphere and the precipitation have significance above all for an analysis of the processes of climate formation, but they also hold for individual cases of precipitation and can be used for forecasting the amount of precipitation several days in advance. In such work the moisture elements should be taken in the precipitation-forming mass (the center of formation or in the warm sector of the cyclone), and the characteristics of the updrafts should be evaluated according to the form of circulation.

While evaporation contributes to increasing total precipitation over a

continent, enforced condensation leads to opposite results. Hence, the role of mountainous or dissected relief, as well as other factors of roughness increasing precipitation in windward areas, is a negative one with respect to the moisture of the leeward part of a territory. Mountain relief increases the total precipitation of a continent only in cases where the mountains are situated in the leeward part of the continent or in very dry regions, where a large part of the vapor is not used to form precipitation on the plain; in all other cases the relief at best redistributes the precipitation, but can also result in a diminution of the total amount over the continent.

Although the geographic laws of the distribution of precipitation are still far from having been fully studied, especially on the plain, we have been able to compile precipitation maps at fairly large scales, of the order of 1:500,000. The compilation of such maps has shown that the distribution of precipitation over a territory is very complex and is characterized by substantial contrasts over short distances. Major differences in precipitation depending on the physical-geographic conditions make it possible, in spite of the above-mentioned defects of precipitation measurement, to ascertain the laws of distribution depending upon the altitude of the slopes not only in mountains but also on the plain. The latter has a physical basis when the horizontal scales of the elevations amount to tens of kilometers or more. The dissection (roughness) of the terrain also has significance. Various authors evaluate differently the relationship between these two factors in the formation of lowland precipitation. Actually, it is hard to separate their influences; and different results are obtained according to what a given author attributes to each of these factors. If one attributes to the effect of roughness the part of the effect of elevation that remains after computing the action of the slopes, then both factors exert an influence of approximately the same order upon precipitation and together they raise the amount of precipitation on the plain by 100 mm. a year per 100 meters of rise. In purer form, the effect of roughness manifests itself in the shape of forest cover, the effect of towns and cities, and so forth. For the precipitation of the warm season of the year, which can be determined with relative accuracy, forest cover causes a 4% increase in precipitation for each 10% increase in forest cover in the windward part of an area of great roughness, but a diminution of precipitation is sometimes also discovered in the leeward part of the area. When there are great differences in forest cover, this effect outweighs by several times the inaccuracies of precipitation measurement due to wind action (amounting to about 10% for liquid precipitation) and must be recognized as a real factor. Among the cities of the USSR, a definite influence upon precipitation is evident only in the case of Moscow, where the precipitation is 12% greater than in the surroundings. This difference also somewhat exceeds the effect of the wind upon the under-recording of precipitation. Still not sufficiently studied are the characteristics of redistribution of precipitation by the wind over an area of several kilometers. This redistribution is especially significant in the case of solid precipitation where drifting continues even after the formation of a snow cover. The snow cover is therefore distributed more unevenly than the precipitation; however, the laws of distribution of snow under various terrain conditions have been studied better

than the precipitation itself. Of no less significance are the geographic conditions of the distribution of evaporation. Great progress has lately been made here, both in general theoretical studies on evaporation and evaporability (M. I. Budyko and A. M. Budagovskiy) and numerous studies on evaporation under concrete landscape conditions (from cropped field by A. M. Alpat'yev, from swamps by K. Ye. Ivanov and V. V. Ramanov, and so forth). However, many questions of this sort, in spite of the extensive research, continue to remain subjects of discussion (for example, the question of the evaporation by forest and, in general, the water balance under forest conditions; similarly, the influence of plowing upon the water balance, and so forth). The greatest magnitudes of evaporation from the land may exceed 1,000 mm. a year and 100 mm. in certain months; but the greatest evaporation from water in the tropical regions exceeds 2,000 mm. a year. On the average for the whole land mass of the globe, precipitation amounts to 700-750 mm., evaporation 450-500 mm., runoff about 250 mm. a year.

Of especial interest is the water balance of the soil and vegetation. Many questions of the determination of this value are very complex. For example, uplands receive more precipitation, but if the soil there is not sheltered, the snow is easily blown away from the watersheds and the water runs off more rapidly, so that the soil there is often found to be drier than in the depressions. Improvement of the methods of calculating evaporation and evaporability makes it possible, however, to calculate the time necessary for a regular soaking of the soil in irrigation (A. M. Alpat'yev). And on the basis of the presence of known moisture reserves in the soil, the state of the crops at a definite moment of time, and the prospect of certain additional amounts of heat and moisture in the future, rather successful agrometeorological forecasts are now possible.

Let us now take up the possibility of changing the natural processes. Direct action upon the course of atmospheric processes designed to change their movement has thus far not been very effective because of the immense scale of these processes, although man is already in a position to change the character of weather substantially at very high cost. Changing the water balance of the atmosphere as a result of changing climate over a large territory is, generally speaking, not only possible, but is constantly being done by man by changing the relationship between runoff, evaporation and precipitation, in the process of cutting down and planting forests, draining swamps, developing lands for agriculture, irrigation, and so forth.

Calculations show that these changes are usually relatively small and capable of changing the amount of precipitation only within the limits of 0.1-0.2 per cent, which is considerably less than the changes that take place in the water balance of the active surface and soil when such measures are carried out. The change in the moisture circulation of the atmosphere caused by a change in evaporation or by a change in the roughness of the active surface must for the present still be regarded as an incidental effect of great reclamation projects or of some other transformation of nature.

A change in the atmospheric circulation as a result of the transformation of the heat regime of the active surface over a considerable area may produce substantial changes in the precipitation regime; however, it has undesirable side effects; thus, in the temperate latitudes an increase in precipitation may be brought about by an increase in the differences in temperature between north and south, i.e., practically through cooling of the Arctic areas. On the other hand, all projects for heating the Arctic have as an inevitable consequence the diminution of precipitation in the temperate latitudes. We have examples for such a phenomenon in contemporary fluctuations of climate in paleoclimatic analogues. We still have to determine what conditions are to be considered optimal at the present stage: whether to stabilize the climate at conditions close to the present ones, or at conditions with somewhat lower temperatures in the north than the present ones, which would insure a good water supply for areas having the greatest agricultural significance.

A change in the amount of precipitation with a small expenditure of energy can result from action upon cloud formation. But while the benefits of such action are fairly obvious for the elimination of comparatively rare harmful phenomena (dispersion of fog, flood and hail control), as is already being done systematically in some places, the possibility of effective interference in the natural processes has not been investigated with respect to a substantial increase in precipitation over large areas. The fact is that large clouds are often entirely lacking in dry weather. In cases where there are clouds, it is not clear to what extent the water precipitated from them actually moistens the soil and what value such interference has under present conditions. After all, we know that a precipitation of less than 5 to 10 mm. is of no significance for crop growth. It should be borne in mind that the precipitation of moisture in dry weather reduces the already low moisture content in the air and contributes to the intensification of rainlessness, whereas, when cloudiness is allowed to develop, the probability of precipitation is great even without special action. Naturally, geographic regions are likely to be uncovered where artificial action upon clouds will be justified, but for the time being there are neither in the Soviet Union nor abroad sufficient data for judging the effectiveness of cloud precipitation for the purpose of moistening an area, though in the United States such interference is being carried on rather widely.

Incomparably broader possibilities are at our disposal for changing the water balance of the active surface and soil itself. In dry and mainly southern areas, provided with an excess of heat, a struggle is being waged to preserve moisture for the purpose of using it for the productive evaporation of cultivated crops. In humid regions the aim is to remove excess moisture from the soil. The question of the economic advisability of any given reclamation measure in agriculture has been analyzed in a number of articles by F. F. Davitaya.

It should be borne in mind that artificial irrigation, for example, should be applied on a broad scale only where it systematically and substantially

raises the farm income, i.e., where the value of the additional agricultural produce obtained with the aid of irrigation outweighs the cost of irrigation and the overcoming of its harmful aspects in the form of secondary salinification of the soil, which constitutes a large part of the cost connected with the employment of irrigation. This is the case, on the one hand, in desert and semidesert regions with great heat resources, which permit the production of large quantities of high-value crops (cotton, rice, etc.) and, on the other hand, in regions with unstable or moderate moisture, where vegetables are grown. Rational utilization of water for irrigation and the problem of providing the optimal climatic conditions while preserving the fertility of the soil are now being solved with consideration for the transformation of the heat and water regime in irrigation. A combination of geographic and physical-mathematical methods of investigation is to be recommended in such calculations.

In regions of uneven or insufficient moisture for agriculture rational use must be made of the available moisture resources, particularly winter moisture, by snow retention, the planting of windbreak belts of tall shelter crops, and so forth, and summer moisture by means of such belts and modern methods of agrotechnology, particularly fallow lands, grassland farming, special methods of tilling the soil, etc. Each of these measures is effective under certain natural and climatic conditions and may be found useless, and sometimes even harmful, under others.

In the process of utilizing moisture for agricultural purposes in regions of insufficient moisture, the surface runoff is reduced, and a part of the water that formerly ran off into streams is used for evaporation. The question of the magnitude of this transformation of the water regime is now a matter of discussion among hydrologists. Some (for example, M. I. L'vovich) consider that as a result of agrotechnical measures the runoff in regions of insufficient moisture can be subjected to substantial changes. Other investigators consider the proportion of runoff transferred to effective evaporation to be insignificant, and see the main effect of the agrotechnical measures in a change from non-productive to productive evaporation. To solve this question, it is necessary to do serious experimental work under various climatic and weather conditions. The practical significance of taking proper account of the moisture resources that can be directed to agricultural purposes and of anticipating the concomitant changes in the runoff is very great, and it is necessary to work out as rapidly as possible methods of scientific calculation of the change in the water balance of the soils and vegetation of arid areas. Of especial significance is the transformation of the water balance under dry-wind conditions.

Rational utilization of the local moisture resources make it possible even in the driest years to obtain excellent crops in the steppe zone, although the effect of weather factors upon crops not only does not diminish in this case but becomes even more noticeable, occurring at a higher guaranteed level of yield. Less theoretical work has thus far been done to control excess moisture under swamp conditions, but this also involves a complex transformation of the water balance of a territory.

Thus, upland (moss) swamps, which have no agricultural value, are being subjected to deep drainage for the purposes of peat extraction. In this case the proportion of water going into evaporation is sharply reduced, especially because the capillary properties of peat do not enable the water to be drawn to the surface when the ground-water level is more than one meter from the surface.

Quite different is the readjustment of the water balance when lowland (herbaceous) swamps are drained for use in agriculture. Here shallow drainage is designed to bring the moisture up to the surface to feed the plants and rapidly decompose the peat itself. Moreover, damp peat is subject to smaller ranges of temperature than dry peat. If the top layer of the peat dries out too much, irrigation is employed without danger of salinifying the soil. As a result, there develops on the peaty soil a luxuriant vegetation, from which evaporation amounts to at least 80% of evaporability, similarly to the conditions on irrigated plots. As a result of swamp drainage for agricultural uses, the water balance is thus readjusted in favor of an increase in the proportion of precipitation going into evaporation. This increase is especially noticeable in the more southerly areas, where shrub micro-landscapes predominate on swamps, and it is reduced to zero in northern areas, where according to V. V. Romanov's estimates evaporation from swamps highly saturated with moisture approaches the evaporation from an open water surface.

Another task involves the utilization of crop lands on mineral soils in zones of excess moisture. Here farm work is made difficult by periodic overmoistening (chiefly by thaw water in spring and rain water in fall). The task consists in a rapid draining of the surface waters, which according to the investigations of Leningrad State University cannot be achieved by a widespread network of deep ditches, but must be accomplished by a comparatively dense network of permanent or temporary shallow ditches.

Such reclamation speeds the commencement of farm work and consequently promotes an earlier and more vigorous growth of plants. It contributes to an intensification of runoff in spring and fall through elimination of stagnating water on the soil and to a certain increase of evaporation in the summer, as well as to a better warming of the soil. In regions of excess moisture and large snow accumulations in winter (Kamchatka, the lower Yenisey, the Urals Foreland, and certain mountain regions), it is advisable, in order to prolong the growing season, to adopt measures to speed the disappearance of snow from the fields (as is already being done in Kamchatka). This measure increases the radiation balance, warms up the soil and increases summer evaporation and spring runoff.

Finally, in northern, humid regions the ridge tilling of the soil is found to be advisable, as it contributes to the runoff of excess surface water, to the heating of the ridges and, in conjunction with the development of vegetation, to an increase in summer evaporation.

Thus, agricultural practice substantially transforms the water balance of

the land over considerable areas. In arid regions this transformation contributes to moistening the soil and increasing the productive evaporation by reducing the proportion of non-productive evaporation and runoff. In desert regions wide use is made for this purpose of the water resources of neighboring territories (artificial irrigation). In regions of excess moisture the task reduces itself to freeing the soil of the excess surface and ground waters, which contribute to a better development of vegetation and increases evaporation in summer. The study and elaboration of the most suitable forms of transforming the water balance of a territory are still in their early stages. In the present stage of development of science these aspects of the investigation of the water balance are the most timely for practical purposes. Changes in the water balance of the atmosphere are thus far still mainly of theoretical interest, though they must already be taken into account, for example, in large-scale reclamation projects.

THE PRESENT STATE OF LANDSCAPE STUDIES

By S. V. Kalesnik

It is generally known that the earth's surface has been divided in a natural manner, in the course of its development of millions of years, into a multitude of sections differing qualitatively from one another in an aggregate of many interrelated external features and internal characteristics. These sections have received the name of geographic landscapes. Their objective existence in nature and the necessity of recognizing them have led to the rise and development in physical geography of a special division - landscape science.

The content of landscape science

Landscape science is identified with regional physical geography, the main object of which is the study of the characteristics of formation, composition, structure, development and geographic distribution of individual landscapes or their natural groupings.

Landscape science, however, cannot be confined to descriptions of concrete landscapes alone. As a result of the comparison of such descriptions, conclusions of general significance are inevitable, i.e., the theoretical foundations of regional physical geography arise. Consequently, landscape science includes both the description and analysis of existing landscapes and a general landscape theory. The broad development of landscape surveys in the Soviet Union in the last few years has engendered in certain geographers the opinion that the task of landscape science can be reduced to large-scale and medium-scale investigations of areal complexes directly in the field. Such a view must be rejected: landscape science is regional geography, not microregional.

Theoretical conceptions of landscape science, though they have now attained a fairly high level, are still not free of contradictions and obscurities. This will be the subject of our article.

Content and treatment of the "landscape" concept

Obscurities and contradictions reveal themselves above all in the numerous attempts to give a formal definition of landscape. These have thus far not led to any generally accepted formulation. Still, the lack of a definition on which all geographers agree does not greatly hinder the development of landscape science, just as the lack of a generally recognized definition of climate does not interfere with the development of climatology.

Much more essential are the disagreements in the treatment of the content of the concept of landscape. There are three variants of this treatment:

1. Landscape is a general concept, analogous to that of soil, relief, organism, climate.
2. Landscape is an actually existing section of the earth's surface, a geographic individuum and, consequently, the basic territorial unit in physical-geographic regionalization.
3. Landscape is a typological category similar to the species in biology and, consequently, the basic unit for the systematization of territorial complexes. (Although the co-subordination of taxonomic units in the process of physical-geographic regionalization also contains elements of systematization, we prefer to designate as systematization, in the proper sense of the word, the grouping of objects by typological features, as is customary in all the other natural sciences.)

There are no considerations controverting the possibility of treating landscape as a general concept. But since the term, because of its generalness, becomes indefinite in this case, it is best not to use it in this vague sense.

The content of the concept of landscape as a geographic individuum is virtually identical in the minds of most adherents of this treatment. A landscape is an actually existing and genetically homogeneous section of the earth's surface; it is framed by natural boundaries; it possesses individual features permitting one to distinguish it from other landscapes; it does not represent an accidental or mechanical, but a law-governed and internally interrelated combination of components and structural peculiarities; it is unduplicated in space and in time; it is characterized by territorial integrity, i.e., it cannot consist of parts isolated by the territory of another landscape; it is morphologically heterogeneous within itself, since it is composed of various territorial complexes of lower rank; at the same time it is homogeneous, since the general style of combination of the heterogeneous components and structural peculiarities is preserved unchanged within the landscape.

In the typological treatment of the landscape, its features are of a different

kind. It is no longer an individual section of the earth's surface, but a sort of generalized idea of an aggregate of similar characteristics peculiar to a certain group of different and at the same time similar concrete territorial complexes. In the formation of such an idea, the individual peculiarities are crowded into the background, and features of similarity are brought to the foreground. This is the way the biologist proceeds when he characterizes a species on the basis of a study of many thousands of specimens. The landscape, viewed on the typological plane, is duplicated both in space and in time, and its area may be fragmented.

How does the idea of the type of landscape arise? One way is that one first studies geographic individua, then compares them and, on the basis of a generalization of the features, forms a concept of the type. In this case the recognition of the landscape as an individuum is primary, while the idea of the landscape as a certain type of territorial complex is secondary. Another way is that one first studies an extensive and, at first sight, more or less homogeneous territory and then, in the course of more detailed investigations, discovers in it a breakdown into individual sections. Here the typological notion is actually formed earlier than the regional.

Of the above-enumerated two ways, the first is the more reliable. It is on better logical ground (proceeding from the concrete to the abstract) and at once leads to definite results; the individual landscape is difficult to accept as a type of landscape. In the second way, if the investigations are not detailed enough, it is easy to accept a group of similar landscapes as a single geographic individuum.

In defining the object of a science, it is best to choose that treatment of the object in which its general diagnosis and discernment under field conditions can rest on the maximal number of concrete features. In this sense, the concept of landscape as a geographic individuum has clear advantages.

Conclusion: landscape should be understood as a geographic individuum. For typological characterization, it is recommended that the term "landscape species" be chosen as the basic unit of systematization.

Geographers also disagree about the question of whether there are landscapes everywhere on the surface of the earth. Some- not many, to be sure - consider that landscapes are territorial complexes peculiar to land areas. However, there are no convincing grounds for not considering as landscapes the sections of the ocean surface or the ocean floor; they, too, differ qualitatively from one another in the aggregate of their features and peculiarities.

Morphologic units of the landscape

It has been established and generally recognized that the landscape consists of smaller territorial complexes of different sizes. They are called morphologic units. (It has also been proposed to call the components of the

landscape morphologic parts of the landscape, inasmuch as it is the components that fulfill the vital functions in the landscape, as do the morphologic parts in organisms. But this proposal has not found wide acceptance.). Morphologic units are duplicated within the landscape with a certain regularity. The largest territorial complexes into which the landscape breaks down are urochishcha (natural units); the smallest into which the urochishcha break down are facies (fatsii). The facies should consist of a given type of rock and possess a uniform relief, uniform microclimate, a single kind of soil and only one biocoenosis.

The landscape, taken as a whole, is original and unduplicated. The urochishcha (natural units) and facies are not original; however, this only means that the individual differences between two similar urochishcha or facies are much smaller than between two similar landscapes.

It has been ascertained from the practice of landscape field studies that, in addition to natural units (urochishcha) and facies, additional morphologic units have to be isolated in the landscape. The terminology of morphologic units is not yet uniform. There are several schemes of terminological subdivisions within the landscape, for example (in descending gradation: Landscape - landscape section (landshaftnyy uchastok) - locality (mestnost')- natural unit (urochishche) - facies (fatsiya); landscape - locality - natural unit - facies; locality (in the sense of landscape) - complex natural unit (slozhnoye urochishche) - simple natural unit (prostoye urochishche) - facies; landscape - complex of natural units (kompleks urochishche) - natural unit - group of facies (formation (formatsiya) - facies; and so on.

Certain geographers do not accept the facies as an object of geography. But this point of view is found to be isolated, inasmuch as it is controverted by the practice of almost all landscape field investigations.

The subdivision of the landscape into morphologic units is sometimes called "intra-landscape regionalization." This is a mistake, for regionalization is the process of distinguishing and grouping geographic individua, among which morphologic units are not reckoned.

In the various schemes of morphologic units two members are invariably and necessarily present: facies and natural units. They must be regarded as basic and universal. However, the need for additional units is also unquestionable, since the morphologic structure of landscapes, as we see, does not fit into a two-member system. The scope of the content of the additonal units, in spite of the disagreement in their names, is also clear insofar as their relationships to the basic units are clear. It is up to a competent commission to concern itself with the unification of this whole terminology.

The theory of the morphologic structure of the landscape has been enriched in recent times by the idea of dominant morphologic units (dominant natural units, dominant facies) and a thorough elaboration of the concept of facies. The Latvian geographers have established that: (1) each natural facies

consists of two complexes, a geocoenosis and a biocoenosis, which are in a certain agreement with each other; (2) man's action upon nature results in the formation of anthropogenic facies, which are marked by great diversity of transitional stages or by the modification of the fundamental facies; (3) not every law-governed complex of facies forms a natural unit, because facies can be grouped, for example, in special "series of facies," situated along a slope and interrelated by the migration of material and by the distribution of microclimatic traits and moisture along the slope.

The notions about morphologic units for mountain areas, are still in an early stage of formulation.

The geographic structure of the landscape

Every landscape is a certain material system of interrelated bodies and phenomena, typically expressed over a considerable area. The basic constituent parts of the landscape or its components include: relief, solar heat, air masses, water accumulations, soil cover, biocoenoses. The internal organization in the landscape of objects and phenomena is called the geographic structure. By geographic structure of the landscape is meant the aggregate of its three characteristics:

(1) the character of the interrelation and interaction between the separate components of the landscape:

(2) the character of the combination of the morphologic units in the landscape, definable by the interaction of the components;

(3) the most important traits of the seasonal rhythm of the landscape, expressed in the succession of its aspects.

The development of the landscape

The landscape develops as a whole under the action of the internal conflicts and external phenomena. But the various objects in the landscape enter into interaction with various degrees of activity depending on the qualitative characteristics typical of each; because of this the rates of development of the components making up the landscape and of the morphologic units do not coincide. Moreover, the external conditions exercise different types of influence (acceleration, retardation) in different landscapes on the course of a given phenomenon. Hence, in each landscape there are traits and morphologic units of a triple order: contemporaneous or conservative, i.e., giving the landscape its contemporaneous appearance; residual, those which have survived from preceding stages of development; progressive, i.e., those which arise anew and are destined to grow constantly stronger. The residual traits help to reconstruct the history of the landscape; the progressive ones, to predict the general direction of its development.

The irregularity of the development of the component parts of the landscape renders difficult our conceptions of (1) the genetic homogeneity of the landscale (2) the age of the landscape.

That the landscape is a genetically homogeneous territory consisting of heterogeneous but mutually conjugated sections has been agreed by all geographers. It is also easy to conceive that the landscape is more stable than its morphologic units. Generally speaking, the stability (in time) of the structure of a territorial complex is proportional to its taxonomic rank. The degree of genetic homogeneity also varies with the change in taxonomic rank of the geographic units, but here the dependence is rather the reverse.

By genetic homogeneity of the landscape is to be understood the general course of its development, not by any means the simultaneous appearance of the whole complex of its components. The age of the landscape is defined from the moment when it has acquired the geographic structure characteristic of its present state.

Classification of landscapes

In landscape science two methods of classification are used: on a regional basis and on a typologic basis.

The classification on a regional basis (identification and grouping of geographic individua) is physical-geographic regionalization. At present, work on regionalization is being done on a wide front by large scientific teams (the Council for the Distribution of Productive Forces, the Institute of Geography of the Academy of Sciences of the USSR, the geography faculties of almost all the universities); tentative schemes have been worked out for the regionalization of large territories (the Russian Plain, the Caucasus, Soviet Central Asia, the Urals and the Ukraine); much attention is being paid to harmonizing the taxonomic gradations. This is understandable, too, since physical-geographic regionalization, besides its theoretical value (the synthesis, the result and, at the same time, the starting point for further regional physical-geographic investigations), also presents great practical interest, above all as one of the important premises for economic regionalization and economic planning by areas.

The inter-university conference in Moscow on natural-historical regionalization (February 1-5, 1958) recommended the following taxonomic system of units:

Country - zone (within the country) - province (or oblast) - subzone (subprovince in the mountains) - okrug - rayon.

The name of each unit is preceded by the adjective "physical-geographic" or "landscape." This gradation is not undisputed, but on the whole it apparently reflects the views of the majority of geographers. The landscape, as the starting unit, has here been given the name of "physical-geographic rayon" or "landscape rayon."

In regionalizing a territory, account is taken of its genesis (the origin of the whole complex of natural conditions of the territory) and the contemporaneous structure in all its aspects.

A detailed review of the problem of physical-geographic regionalization is contained in special papers presented to the Third Congress of the Geographic Society of the USSR. Here we shall make only two observations:

1. There is a tendency to separate questions of physical-geographic regionalization from landscape science and put them in a distinct department of physical geography. The motive is that physical-geographic regionalization is a special kind of systematization, resting not only on the conclusions of landscape science, but also on laws establishable by general geography. The motivation is a weak one. Any landscape can be viewed against the background of general geographic laws, but this has thus far not served as a ground for including regional physical geography in general geography. Furthermore, as has already been observed, physical-geographic regionalization is the result of regional investigations (all full-fledged geographic regional monographs culminate in regionalization), and it would be artificial to single out the results as a special branch of knowledge.

2. In the opinion of some geographers, physical-geographic regionalization is impossible unless it is confronted with a predetermined practical task. This opinion means:

(a) objective denial of the existence of territorial complexes meriting classification on the basis of inherent qualitative characteristics,

(b) objective agreement upon a senseless waste of energy and means such as would be required by the compilation, for a given territory, of dozens of schemes of regionalization answering dozens of practical demands.

Physical-geographic regionalization is above all necessary for the solution of the task of landscape science itself: it must reflect whatever exists in nature, i.e., the different groupings of actually existing territorial complexes independently of man's economic relationship to them. The objective picture obtained can then, through itemization or generalization, selection or emphasis of the necessary features or indices and so forth, be adapted to practical requirements, either in the office or by small supplementary field investigations designed to adapt the general scheme to a particular need.

Unfortunately, less attention has been paid to the systematization of landscapes on a typological basis than to regionalization, and that systematization is still in its initial stages. It is sometimes called "typological regionalization," which is entirely incorrect.

Typology, like regionalization, summarizes our knowledge of geographic landscapes, though under another (systematic) aspect. Without establishing typical traits it is impossible to discover laws. Without typing the territorial complexes their recognition would be accompanied by a colossal waste of effort, but with a typological approach the study of a countless multitude of individua is replaced by the study of a limited number of types. Economic measures can also be worked out more conveniently in application to types of landscapes rather than to separate landscapes. Still it must not be forgotten that the study of individual landscapes also has great scientific and practical sense in a number of cases.

At one time the following series of taxonomic units (ascending in rank) was proposed for the systematization of territorial complexes: facies - group of facies - landscape formation - landscape class - landscape type - landscape division (there are three divisions: plains landscapes, mountain landscapes, water landscapes).

Present-day authors arrange these units (if we discard the terms of intra-landscape subdivision) either in the series: species - group -subtype- type; or in the series: landscape species - landscape class - landscape subtype (optional unit) - landscape type.

There is also a proposal to call the simplest, not the highest, unit in the systematization (similar to the species in biology) "landscape type," above which are successively located the landscape class and formation.

Natural units and facies are generally assigned to the category of typologic units. This concept is inexact, but it has been born of practice: in a medium-scale landscape survey the identification of individual facies and natural units is impossible, and they are at once subject to typing. However, if they are understood typologically, they must be given other names: type of natural unit, type of facies.

Sometimes the regional and the typologic conceptions are sharply contrasted to each other. This is wrong, since the two conceptions are interrelated and intertwined in geographic investigation. The landscape scientist in the field encounters above all very simple individual formations, natural units and facies, but he types them at once for purposes of field mapping; identification of the characteristic combination of types of natural units serves as a basis for isolating the starting unit of regionalization, the landscape or the landscape rayon; the combining of similar landscape rayons into okrugs, of okrugs into provinces, and so forth, i.e., the identification of the major taxonomic units of physical-geographic regionalization is at the same time a new rung in typological analysis.

Methods of landscape investigation

Until recently the compilation of descriptions of landscapes, the typing of landscapes and physical-geographic regionalization were office operations resting on the synthesis of data obtained by representatives of particular geographic disciplines (geomorphologists, soil scientists, biogeographers, climatologists, and so forth). In the last ten years there has been a vigorous blossoming of independent landscape field investigations - landscape field surveying, landscape mapping. The objects of the landscape scientist's field investigations are the morphological units of the landscape and the landscapes (depending on the scale of the investigations; on a map at a scale of 1:200,000 to 1:300,000, it is possible to show individual landscapes; on a 1:100,000 map, natural units; on a 1:25,000 map, natural units and groups of facies (but not each facies separately); the result of the investigations are regional and typological characterizations and maps of

territorial complexes, based on direct observations, not on compilation. It is evident that the direct study of the territorial complexes existing in nature is not at all the same thing as "montage" of these complexes by analyzing and then mentally combining their components one by one. Landscape mapping is now one of the most important problems of physical geography, the solution of which can enrich the theory and improve its practical application.

Detailed questions of landscape mapping are examined in A. G. Isachenko's paper.

Landscapes are studied by the methods of the natural sciences. Some of these methods have become traditional in landscape science and, insofar as they have not yet exhausted themselves, geographers will continue to use them. However, owing to the progress of aerial photography, physics and geochemistry, a new methodology, reposing on the latest achievements of these branches of science, is also penetrating into the investigation of landscapes. This process of penetration, however, is rather slow. Not all geographers realize the possibilities of the new methods, but the main thing is that not all possess the necessary know-how for their application. It is known that the method of investigation sometimes plays a decisive role in the development of a science, and the mastery of new methods opens heretofore unknown horizons to science. For example, mastery of the method of landscape field surveying has greatly advanced the theory and practice of landscape science.

Of great significance will be thelandscape study stations wh ose observations will permit the collection of data for a thorough analysis of landscape by means of certain quantitative indices, the characterization of the seasonal rhythm and, possibly, the general course of development (in case of a long series of observations).

The use of the latest physical and chemical methods in landscape science will open to investigation the minute structural characteristics of the landscape and will aid in clarifying the essence and nature of many processes and interrelationships, and a wider application of aerial photography to landscape investigations will insure the availability of new, objective and accurate data.

Geographers, of course, have never stood aside from progress in other sciences: they have long sought explanations for landscape phenomena in the laws of chemistry, physics, mechanics and biology. Nor have they shunned quantitative evaluations (climatic and hydrologic indices, slope measurements, magnitudes of denudation, energy of relief, biological productivity, and so forth). Recently, with the aid of physical methods they have succeeded in discovering a periodic law in the distribution of landscape zones over the earth. But modern physics furnishes further possibilities for determining the absolute age of landscape objects, for investigating a number of processes by means of tracer isotopes, for establishing the position of magnetic meridians in the past (paleomagnetic methods), and so forth.

The study of the basic geochemical traits of landscapes and types of geochemical aureoles formed by the migration of chemical elements in various territorial complexes furnishes material for compiling landscape-geochemical maps, very useful to agriculture (growth substances, micro-fertilizers, etc.), sanitation and hygiene (elements useful or harmful to health), for discovering mineral deposits, and so forth.

A characterization of the new methods in landscape science is contained in the paper by M. M. Yermolayev.

The practical significance of landscape science

The study of landscapes is of practical interest above all because man's economic activity is not displayed in the geographic environment in general, but in concrete geographic landscapes. A difference in landscapes presupposes a difference in the possibilities and ways of exploiting them economically. Hence, any landscape map has economic value, even if not yet interpreted for practical purposes by various cartograms, because its conventional symbols reflect by themselves the diversity of the natural conditions of a territory. Even a simple description of a landscape is valuable. Being a digest of factual material, it forms the basis of any genuinely scientific geographic investigation, and sometimes proves more necessary to the economist or military man than theoretical research.

Especially profound investigations of the landscape, particularly of its internal structure, are required in working out plans for the transformation of nature: if man wants to change a landscape wisely by acting upon one or more of its components, he must know in advance how all the other components will be changed.

We not infrequently encounter an underestimation of the importance of geographic investigations. This means an underestimation of the generally known tenet of dialectic materialism that the geographic environment is one of the constant and indispensable material conditions for the existence and development of human society. Everything that man needs for his biologic and productional activity (from air for breathing to the fissionable materials used in atomic reactors) he can obtain only from the geographic environment. Disregard of the geographic surroundings results in grave consequences (the collapse of the grass-rotation system in the southern areas, the conversion of fertile lands into swamp through the damming of rivers, the salinification of lands as a result of immoderate irrigation, the erosion of soils because of the plowing of steep slopes, and so forth).

Geographers have the duty to: (1) patiently and insistently explain to everyone who does not yet understand it, the importance of comprehending the geographic environment, (2) strive to attain in landscape investigations scientific results of such significance that their application in the solution of economic questions would of itself bespeak the practical value of geographic research.

Landscape scientists are highly conscious of the weak sides of their work. They suffer from it more than any sideline critic, and therefore they need no exhortations about the necessity and usefulness of joining theory with practice. They need only businesslike advice about the best way of achieving this relationship.

LANDSCAPE MAPPING

(Its Significance, Its Present State and Its Tasks)

By A. G. Isachenko

The objects of landscape mapping are geographic (or natural territorial) complexes, i.e., law-governed territorial combinations of components of the geographic envelope. The integrity of the geographic complex follows from the fact that all the components of the geographic envelope - climate, surface rocks, relief, surface and underground waters, soils, phytocoenoses and biocoenoses - are mutually conditioned and develop as parts of a single natural system. Geographic complexes are material systems of different degrees of complexity (of different orders), interrelated by a definite mutual co-subordination. The study of the territorial differentiation of the geographic envelope, i.e., the formation, development, structure and distribution of geographic complexes, constitutes the task of landscape science as a special department of physical geography.

Among the basic methods of studying geographic complexes is the cartographic method. There are two modes of cartographic representation of geographic complexes: analytic and synthetic. The essence of the first mode consists in that the content of a geographic complex is revealed by simultaneous representation on one map of its separate components - relief, soil, vegetation and so forth. The synthetic method consists in entering on the map the boundaries between the geographic complexes themselves and representing (with the aid of a suitable system of symbols) their typological similarity.

The analytic map, in spite of all the technical complexity of its execution and reproduction, does not provide a sufficiently full characterization of all the components and, above all, does not directly convey the geographic complexes as such. The more promising is the second method, i.e., the compilation of synthetic or typological landscape maps. Below, when speaking of landscape maps, we shall mean maps of the synthetic type. The reproduction of such maps does not cause any great difficulties, they are easy to read and present considerable scientific and practical interest, inasmuch as they give in one symbol a synthesis of many natural factors.

Depending upon the scale, landscape maps may be subdivided into three groups: large, medium and small-scale. To each group there correspond

mapping units of a definite order. As a first approximation it is possible to consider that mainly facies are represented on the large-scale maps, natural units (urochishcha) on the medium-scale ones, and landscapes on the small-scale ones. (The landscape is here understood as the basic physical-geographic unit in accordance with the ideas of the geographers of the Leningrad school, and also of A. A. Grigor'yev, N. A. Solntsev, K. I. Gerenchuk and other geographers.)

The very idea of a landscape map and the appearance of the first landscape maps were by no means the result of theoretic reasonings, but were the consequence of practical necessity. In first propounding, in 1904, the task of creating such maps (though not calling them landscape maps), G. N. Vysotskiy was guided by the interests of agriculture. The first landscape maps began to appear in the 1920's; they were compiled independently of one another by investigators of various specialties in the process of solving such problems as the evaluation of land reserves (including natural forage lands), reclamation, the determination of the specialization of agriculture, and so forth.

B. B. Polynov, one of the pioneers of landscape mapping, wrote in the early 1920's that the landscape map "is at the same time a living and a comprehensive soil map." Questions of a practical character, such as land reclamation, inevitably require elucidation precisely by means of landscape maps. (B. B. Polynov and M. M. Yur'yev, "The Lakhta Depression," Izv. nauchn. meliorativn. in-ta, No.8-9,1924, p. 84.). At almost the same time I. V. Larin, who had studied for a number of years the land reserves of the Northern Caspian region, also came to the conclusion that the best means of inventorying and agriculturally assessing lands was the large-scale mapping of "micro-landscapes." In the legend to the map compiled by I. V. Larin, each contour not only is characterized by the main natural conditions (relief, effect of winter floods, soils, vegetation), but is also given an agricultural evaluation (yield and quality of hay, arability, and so forth). Similar maps were compiled in the late 1920's by R. I. Abolin (for southern Kazakhstan). Thus, the first landscape maps already served both for the agricultural evaluation of a territory and for recommendations regarding a more rational utilization.

Being unable to examine the whole subsequent history of landscape mapping, I will cite only a few examples of the later work. It includes, in particular, the work of the Zaraysk expedition of Moscow University (1950-53) under N. A. Solntsev, which covered 32 kolkhozes and two sovkhozes with a large-scale landscape survey; the maps were handed over to the rayon authorities and are used as a basis for land organization and for compiling schemes of sowing and harvesting and other operational economic documents. Similar work was done by the landscape scientists of Moscow University in Sapozhok Rayon, Ryazan' Oblast (1954-56). In the last few years A. F. Voronin and V. A. Nikolayev of Moscow University have compiled a medium-scale landscape map of Kustanay Oblast for the purpose of aiding the local authorities in agricultural planning (in particular, in adapting

agriculture to natural conditions). By interpreting the landscape map, the authors compiled a map of productional types of lands and a map of feed resources.

Landscape maps of individual ("key") kolkhozes of the Northwest of the Russian Plain and Vologda Oblast were compiled by geographers of Leningrad University.

A series of maps similar in character to the landscape maps (titled "maps of locality types") has been created in the Institute of Geography of the Academy of Sciences of the USSR. Some of them (for the arid territories) were compiled for the purposes of working out measures for water supply, irrigation and afforestation. The latest work of the Institute of Geography, a map of locality types of the Buryat ASSR, compiled by V. S. Preobrazhenskiy with a group of associates, is to serve as a basis for refining the schemes of specialization of agriculture.

One of the most promising trends in applied landscape mapping is connected with the qualitative evaluation and inventory of lands and the compilation of a land cadaster. In speaking of "land types," we mean not only plowland, but also forest land, forage land, and, in general, every kind of natural land that may represent a potential agricultural use. By "land" we have in mind not only the soil, but particularly the relief, the local climate and the micro-climate, the hydrological regime, the natural plant cover and fauna, i.e., the whole complex of natural conditions. In other words, "lands" are simply elementary geographic complexes, the component parts of a given landscape, viewed from the production viewpoint. Consequently, the identification, inventory and thorough description of "land types," with the greatest completeness and scientific accuracy, may be insured by the method of landscape surveying. On the basis of the landscape map, by grouping the natural complexes by their relation to agricultural production and taking into account the whole complex of natural factors, not just the soils, it is relatively easy to identify groups of lands from the point of view of farm production, i.e., to make a quality assessment.

Lately, there have been several investigations of that type. The department of physical geography of the Latvian University has begun to do landscape mapping for the purpose of compiling a land cadaster in a number of rayons of the Latvian SSR. The geographic complexes mapped are types of natural units, which are combined into quality-classification groups taking into account their significance for agriculture. Similar work is being carried on in the Estonian SSR. Geographers of L'vov and some other universities have also joined in investigations connected with the evaluation of lands.

We should also mention the interesting experimental work of D. L. Armand on the compilation of a land cadaster of one of the kolkhozes of Ul'yanovsk Oblast, also executed on the basis of the landscape method.

Doubts have been expressed about the possibility of using landscape maps as a basis for agricultural measures. It is asserted that all the necessary information about the natural conditions for agriculture are given by the soil map. Such a view hardly requires detailed discussion. It is, incidentally, controverted by the soil scientists themselves, many of whom (including B. B. Polynov) have been initiators of landscape maps. To say nothing of the fact that the soil map does not portray directly many important natural factors of agriculture, it must be acknowledged that many defects still exist in soil characterization itself. D. L. Armand, S. V. Kalesnik and other geographers have already called attention to these circumstances. According to a paper by K. T. Kil'dem at the 4th All-Union Conference on Landscape Science, experience in using soil maps in the Estonian SSR has shown that they no longer satisfy the overall requirements of agriculture, and soil surveys in the republic have begun to develop essentially into landscape surveying.

As K. I. Gerenchuk and P. V. Klimovich have shown (from work experience in the western oblasts of the Ukrainian SSR), the study and evaluation of the soils themselves is greatly facilitated if the geographic complexes (natural units, "localities") are first identified.

The sphere of application of landscape mapping should not be narrowed by confining it to the present cultivated lands alone. The chief task consists not so much in insuring the planning of measures on present farm lands as in studying undeveloped lands, in justifying prospects for the expansion of agricultural areas and, in general, in achieving the rational utilization and improvement of the natural conditions of the lands, including so-called useless lands. An example showing what opportunities are afforded in this respect by the landscape method is the work of Ye. A. Galkina (Botanical Institute of the Academy of Sciences of the USSR) on the compilation of swamp-landscape maps. Ye. A. Galkina has shown with concrete examples how landscape maps of swamp areas (compiled chiefly on the basis of the use of aerial photos and indicator features of the plant cover) can be interpreted for various economic purposes. By analyzing landscape maps, she has compiled a series of maps designed for practical application, including maps of: (1) the road-building properties of the swamp areas, (2) the distribution of berries, (3) the hydrographic properties, (4) the distribution of productive plots of land for agriculture, (5) the distribution of productive lands for the peat industry.

In recent years new fields have opened up for the practical use of landscape maps, reaching far beyond the sphere of agricultural production.

One such field is the application of landscape maps as a basis for geochemical prospecting for minerals. In this case, landscape maps with a specialized content, landscape-geochemical maps, are compiled. However, their main content also consists of the contours of the various types of geographic complexes, which are supplemented by certain geochemical indices.

As shown by the work of the Southern Urals expedition of Moscow University under M. A. Glazovskaya (begun in 1956), a detailed landscape map, showing "elementary landscapes" (i.e., the types of facies, in the most generally accepted interpretation), makes it possible to establish the secondary aureoles of dispersion of the chemical elements and to discover laws of formation. The occurrence of secondary aureoles of dispersion depends upon the complex of physical-geographic conditions; the various geographic complexes differ in the conditions of migration of the chemical elements. The landscape map thus permits the planning of differentiated prospecting methods. The methodology of landscape-geochemical prospecting worked out by this expedition has already been adopted in the practice of the Southern Urals Geological Administration.

In the near future, the geographers of the Leningrad University also propose to begin landscape-geochemical research for prospecting purposes.

As M. A. Glazovskaya observes, landscape-geochemical maps can find use also for other practical purposes, particularly agricultural (distribution of fertilizers, including trace elements), sanitation and hygiene, and so forth.

Still another applied trend in landscape mapping is connected with surveys of submarine landscapes, for instance for the purpose of planning the search for fish. Investigations of this sort have been conducted in the Far Eastern seas by the Zoological Institute of the Academy of Sciences and by the Pacific Scientific-Research Institute for Fisheries and Oceanography under G. U. Lindberg and Ye. F. Gur'yanova. Detailed maps of submarine landscapes founded on a study of the interrelations between the geographic components of the sea floor - relief, bottom deposits, character of the water stratum and the biocoenoses - make it possible to forecast the distribution of commercial fish in any season of the year. Let us note, incidentally, that this work clearly confirms the unsoundness of the notions of certain geographers who deny the very concept of submarine landscapes.

The role of landscape maps is also connected with the ever expanding ways of applying aerial methods for various scientific and practical purposes. It can be said that the landscape method is the foundation of all special-purpose (soils, geological) as well as topographic interpretation of aerial photos. The interpretation of "invisible" objects, for example, soils, is possible only by taking into account the entirety of the various indirect physical-geographic features relating to the relief, plant cover, and so forth, i.e., in the last analysis, it reduces itself to distinguishing from the aerial photos the geographic complexes with subsequent characterization of each complex with respect to soils (or other elements). With the aid of the landscape map it becomes possible to extrapolate interpretation indicators of a given component, established by a ground examination of individual "keys."

At present, experiments are being made at the Laboratory of Aerial Methods of the Academy of Sciences of the USSR in the compilation of landscape maps

to develop methods for interpreting recent tectonic movements, for studying the shores of reservoirs and shoreline shallows, and so forth.

The diversity of the applied trends in landscape mapping does not mean that every landscape map must have some specialized purpose and that it is impossible to create a single landscape map with a broad general scientific or practical purpose. However, some geographers scorn landscape maps of the general scientific type compiled without a pre-assigned narrow purpose. V. S. Preobrazhenskiy thinks that "genetic" landscape maps whose content is constituted by the "characteristics of the landscapes themselves" cannot have any practical application, and he opposes to them the "maps of locality types," representing units distinguished for a definite practical purpose. (V. S. Preobrazhenskiy, "From experience in work on the legend of the medium-scale map of locality types with a definite purpose," Izv. AN SSSR, ser. geogr., 1957, No. 3.) Such a view cannot be regarded as correct (especially because, in distinguishing "locality types", V. S. Preobrazhenskiy actually applied the method that all landscape scientists have been using, i.e., he relied entirely on "characteristics of the landscapes themselves").

The genetic approach to landscapes not only does not contradict but, on the contrary, serves as an indispensable prerequisite for any practical application. The amount of detail in landscape maps may depend upon the practical purpose, but the fineness of subdivision has no relation to the principles of division since geographic complexes are identified only on the basis of their own natural features irrespective of the degree of detail. If only narrowly specialized maps are to be compiled, it will soon be impossible to find even two similar landscape maps and we will never succeed in working out a unified compilation method.

Geologists, soil scientists and other specialists are striving to develop a single ("universal") type of map. Geographers cannot be an exception in this respect, preferring the path of empiricism to the scientific development of a single type of landscape map. The foundation for a universal international legend to a geological map was laid almost 80 years ago, and since then it has not lost its scientific and practical significance, but, on the contrary, has contributed to strengthening the authority of the geological map.

There is no need to say much about the scientific significance of landscape maps. They represent a very important basis for theoretical generalizations in physical geography. Only the mass development of landscape mapping, along with the introduction of new methods of landscape studies, including landscape-study stations, can create the conditions for overcoming speculative arguments in our science and for converting geography into an exact science. Such problems as the classification of geographic complexes and physical-geographic regionalization can be placed on a scientific basis only with the aid of landscape maps.

The most reliable method of physical-geographic regionalization, which

is now gaining general recognition, consists in the study of the structure of physical-geographic regions of various ranks, as expressed in the distribution and combination of elementary (morphologic) physical-geographic units (with a simultaneous analysis of the zonal and azonal factors of territorial differentiation). Consequently, the landscape map, showing the laws of distribution of the various landscapes, natural units and facies, does constitute an objective basis for physical-geographic regionalization. Moreover, the landscape typological map reveals the content of the network of physical-geographic regionalization, just as the network of geomorphic, soils or geobotanic regionalization is "interpreted" on the respective typological maps - geomorphologic, soils, and so forth.

Here we find another important, though indirect, practical significance of landscape maps: without them it is impossible to work out a scientific natural regionalization, and the significance of such a regionalization for the national economy is well known.

At present, this method of physical-geographic regionalization is being applied by geographers of many universities, including Leningrad University (North and Northwest of the Russian Plain), Moscow (the Non-Chernozem Center, Kustanay Oblast, the Central Tien Shan) the Latvian (Latvian SSR), L'vov and Kiev universities (the Ukrainian SSR), and Voronezh University (the Chernozem Center). A similar method has been applied by members of the Institute of Geography of the Academy of Sciences of the USSR (V. S. Preobrazhenskiy and co-authors) in the regionalization of the Buryat ASSR.

Landscape mapping has begun to develop with special rapidity in the last several years, chiefly since the first conference on landscape science held in Leningrad in 1955. Naturally, with such a fast rate of development, no unity in working methods can be achieved at once in the first stage, and different trends arise. All the more important therefore is the task of developing unified mapping principles and methods. Obviously, the solution of this problem must commence with a study and generalization of the experience accumulated thus far.

In the present paper I will dwell only briefly upon some of the most clearly defined trends in landscape mapping.

A prominent role in the development of landscape-mapping methods belongs to the landscape scientists of Moscow University, who after World War II began under N. A. Solntsev's direction the experimental mapping of small sections at large scales, and later, as already noted, compiled a number of large-scale maps (1:10,000-1:100,000) to serve agriculture. All these maps are compiled by means of field surveying, partly with the use of aerial photos. The objects represented are chiefly the morphologic parts of the landscape - natural units, facies - as well as intermediate units (in some cases called "formations "). The merits of this work are the rigorous system of units, the application of modern methods of investigation and a rich map content. However, many maps are overloaded because various indices

(soil-forming rocks, present plant cover, and others) are usually entered in addition to the types of typical geographic complexes. The landscape maps of Zaraysk Rayon that Yu. N. Tsesel'chuk exhibited at the first conference on landscape science give numerous symbols and numerical data relating to the various components (genetic types of elementary surfaces, lithology of the relief-forming rocks, contemporaneous geomorphic processes, kinds of soils, thickness of the arable horizon, natural vegetation and its productivity, and so forth). Such an approach does not appear very suitable; it converts the synthetic landscape map into an analytic one and renders its use difficult. The legend of such a map is unwieldy. Obviously, all the particular indices of geographic complexes, including quantitative ones, should be given in an explanatory text or contour-by-contour description, and transferred to supplementary maps (insets).

The above method is not applied by all geographers of Moscow University. Thus, during the operations of the Caspian Expedition, begun in 1951 under Yu. Z. Brotskiy's direction, the contours of the geographic complexes (which did not receive any special appellation and were not combined into types) were established by combining the large-scale maps of the separate components (geomorphic, soil and geobotanic). Later, A. F. Voronina and V. A. Nikolayev, members of that expedition, compiled a landscape map of Kustanay Oblast, also based largely on specialized maps; in the field, the geographic complexes were then identified jointly by a geomorphologist, a geobotanist and a soil scientist. The landscape map of Kustanay Oblast indicates the types of natural units and the "locality types"; the latter are understood as combinations of basic dominant natural units with secondary natural units (marmot burrows, solontsy, and so forth). Actually, the dominant natural units and secondary natural units are shown independently by different symbols.

In 1956-57, an expedition of Moscow University under N. A. Gvozdetskiy's direction, made a landscape survey in the syrts (high-altitude erosion surfaces) of the Tien Shan. Gvozdetskiy denies both the necessity of distinguishing territorial units of different orders and the concept of individual (concrete) landscape units. From his viewpoint, "landscape" is only a general typological concept. These ideas underlie the landscape map of the syrts of the Tien Shan. The "landscapes" shown on them are to a considerable extent identified empirically, without any definite system; in most cases they are coextensive with types of natural units.

The landscape-chemical maps of M. A. Glazovskaya have already been mentioned.

Considerable experience in the compilation of landscape maps has been accumulated in the department of physical geography of Leningrad University. A. G. Isachenko has compiled a series of maps at different scales, ranging from 1:2,000-1:16,000 for certain key sections to 1:1,000,000 for the whole territory of the Northwest of the Russian Plain. The large-scale maps were compiled by means of a field survey with the use of aerial photos; the

medium-scale maps repose on a network of field traverses and an analysis of special-purpose maps, general geographic maps, descriptive literature and other materials. Facies and their groups are mapped at a large scale and types of natural units at a medium scale. Further reduction in scale limits the mapping to dominant natural units. Secondary natural units small in area are shown with background symbols when widely distributed, while natural units having a local character are shown by symbols that are not to scale. In cases where a regular alternation of combinations of natural units is observed in dissected relief (esker, moraine ridge , kame), the map does not show separate types of natural units, but only their combinations. The classification of the natural units of the Northwest was based on conditions of natural drainage (in connection with the character of the relief) and on the character of the substratum; both factors are here viewed against the background of definite zonal and provincial conditions. (For more detailed discussion of the 1:1,000,000 map see Soviet Geography, April 1960, Pages 17-29.)

A similar method was applied by the author in compiling landscape maps of certain regions of China at various scales. Also compiled was a landscape map of all China, on which the objects represented were the landscapes (more exactly, the systematic units of classification of the landscapes: types, classes, species).

O. N. Kazakova has applied a special method of representation for medium scale and small-scale maps; it consists essentially in entering on the map the contours of the major regional units (landscapes, provinces), while their morphologic structure is represented schematically by special symbols characterizing only the relationship between the basic types of natural units (the actual contours of the types of natural units, i.e., their areal distribution, are not shown).

Detailed landscape maps have also been compiled by Z. V. Borisova, D. F. Tumanova and N. S. Chochia, members of the department of physical geography of Leningrad University.

In the Institute of Geography of the Academy of Sciences of the USSR the first small-scale (1:1,500,000 and 1:2,500,000) complex maps (of both the analytic and the synthetic type) were compiled during World War II under the direction of I. P. Gerasimov and Ye. M. Lavrenko. On the synthetic maps the "locality type," an empirical concept whose content and scope were not clearly defined, was adopted as the object of representation. In the following years the Institute of Geography compiled several more maps of "locality types" (mostly schematic) with similar content. Most recently, a group from the Institute of Geography headed by V. S. Preobrazhenskiy compiled a map of "locality types" of the Buryat ASSR. The authors used a method that in general differs little from the usual methods followed by other landscape scientists, but refrained from applying the system of physical-geographic units of different ranks; for this reason the map of V. S. Preobrazhenskiy and his co-authors does not reflect the various degrees of complexity of the "locality types" or their natural co-subordination.

A special trend in landscape mapping is represented by the landscape scientists of Voronezh University, headed by F. N. Mil'kov. According to Mil'kov, the units of landscape mapping are "locality types" and natural units. The maps of the Central Chernozem oblasts (1:1,000,000) published under the editorship of F. N. Mil'kov, show six "locality types"; gently sloping interfluve, riverside, floodplain and so forth. Obviously, "locality types" in this sense represent territorial units possessing only an external similarity, more exactly a similarity in the conditions of location. They are devoid of genetic unity and are identified without taking into account the zonal and provincial geographic differences (as F. N. Mil'kov acknowledges) and, naturally, have nothing in common in climate, mother rocks, soils, vegetation and so forth. To put it more briefly, they are not geographic complexes (unlike the "locality types" of I. P. Gerasimov and V. S. Preobrazhenskiy, which are unquestionably physical-geographic units, though with an undefined scope). The maps compiled by the methods of F. N. Mil'kov are poor in content; they can be regarded only as raw material for a landscape map, or as a "topologic basis" for a landscape map, still to be filled in with a geographic content.

Considerable progress in the field of landscape mapping has been achieved by the geographers of L'vov University. The methods of landscape mapping worked out chiefly by K. I. Gerenchuk are close to those of the Leningrad and Moscow (N. A. Solntsev) schools, although they also have certain distinguishing characteristics of their own. Among the basic objects of landscape mapping K. I. Gerenchuk lists not only landscapes, natural units and facies but also "localities" (mestnosti). "Localities" (which can be combined into "locality types") are regarded in this case as concrete units subordinate to the landscape, i.e., as the largest morphologic units of the latter. Unlike F. N. Mil'kov, K. I. Gerenchuk emphasizes that the system of "locality types" must take into account their regional characteristics, i.e., must be worked out separately for each zone or province. K. I. Gerenchuk has compiled principally medium-scale maps for the western oblasts of the Ukrainian SSR. For certain parts of the same territory landscape maps have been compiled by P. N. Tsys', N. D. Orel, M. M. Koynov and M. A. Chizhov. All these maps show "locality types" or natural units. It must be pointed out that non-comparable units are often distinguished under the name of "locality types." In some cases they do not differ essentially from types of natural units; in others they correspond, as with F. N. Mil'kov, only to the types of locations (gently sloping interfluves, terraces and so forth), while with M. M. Koynov they are identical with landscapes.

A great deal of work on landscape mapping is being done by the department of physical geography of the Latvian University. K. G. Raman has worked out a system of units and mapping methods based on the large-scale landscape survey that already covers a considerable part of the republic. The main objects of representation are the natural units; their classification, carefully worked out as applied to the conditions of the Latvian SSR (taking into account the dissection of the relief, the physical properties and the "trophicity" of the substratum), can be well compared with the system of the

Leningrad landscape scientists. However, the maps of the Latvian geographer are rather complex. This is apparently to be explained by the fact that, in striving to make the classification of the natural units as simple as possible (which he succeeded in doing), its author omitted a number of essential features (the genetic characteristics of the relief and others) that had to be represented separately on the map with the aid of special symbols and indices. Moreover, the classification of natural units with temporarily or permanently excessive moisture (swamps and marshy areas, as well as floodplains) has not been adequately worked out. The system of colored symbols, which in its present form is not very expressive, also needs improvement.

In recent years Soviet geographers have achieved considerable progress in landscape mapping, and landscape maps are gradually gaining wider recognition. However, in this important branch of geography there are still a few deficiencies that can be eliminated only by constant and persistent effort on the part of all Soviet landscape scientists. The Fourth All-Union Conference on Landscape Science held in Riga in August, 1959, confronted landscape scientists with a number of priority tasks in the mapping field. Proceeding from the resolutions of that conference, I will attempt to formulate in somewhat greater detail the basic problems of landscape mapping that appear most timely at this stage.

1. A review of current landscape mapping clearly shows disagreement in the principles of compiling landscape maps and in their content. The main reason for this disagreement is, in our view, the disparate (and in a number of cases incorrect) understanding of the mapped objects (i.e., the geographic complexes) and the principles of their classification.

The objects to be mapped are frequently distinguished and classified almost exclusively by geomorphic or physiognomic features, which results in oversimplification in the methodology of landscape research and in the impoverishment of the map content so that maps lose their scientific and practical significance.

Another widespread defect is the replacement of the typologic landscape map by a map of the analytic type, as a result of which separate, more or less particular, natural indices are mapped instead of the landscape units.

The majority of landscape scientists endeavor to represent on the map geographic complexes of one order or another, the most generally accepted objects mapped at medium and large scales being natural units and facies; however, the principles of classification of these units are still poorly worked out. Moreover, of late, so-called "locality types" are often mapped, but this term is used in the most varied meanings: as a general term (equivalent to "geographic complex"); as a morphologic part of a landscape usually a complex of natural units is meant here, but sometimes the locality type" is practically identified with the "type of natural units"); as a synonym of landscape; and finally as a topologic term (i.e., type of location).

Thus, a priority task of landscape mapping (and landscape science in general) is the ordering of the system of units, the working out of general principles of classifying them and the unifying of terminology. In the solution of these questions, an important role is imposed upon the Commission on Landscape Maps and the Commission on Landscape Terminology under the Presidium of the Geographical Society of the USSR.

2. Poorly worked out are the questions of content of the landscape maps at various scales and the generalization of maps. The solution of these questions rests in turn upon the problem of systematization and classification of landscape units, for the characteristics of the content of maps and the dependence upon the scale and the generalization of maps are determined mainly by the correct utilization of the system of natural territorial divisions, taking into account the diversity of order and the mutual co-subordination of the geographic units.

3. Also directly connected with the preceding questions is the elaboration of a legend for the landscape map. The map legend also expresses the principles of classification of the objects to be represented, the completeness of the map content and the quality of its makeup (and consequently its readability and accessibility for a wide circle of consumers). Hence, the legend acquires especially great importance in landscape mapping and it is intended to devote the next (fifth) conference on landscape science in 1961 to this problem. Comparing the existing legends on landscape maps, we encounter different approaches. Sometimes, the authors confine themselves to brief and one-sided (usually geomorphic or topologic) appellations of the units distinguished ("gently sloping interfluves," "ravines," "sinks," and so forth). The opposite extreme is the conversion of the legends into a veritable explanatory text, with an enumeration of a multitude of particular indices for each component. Obviously, the solution of this question must be based on the establishment of unified principles of systematization and nomenclature of the objects of mapping. It is advisable to start by working out a series of regional legends by coordinating them among the groups working under relatively similar physical-geographic conditions (as recommended by the 4th Conference on Landscape Science).

4. The quality of landscape maps depends, naturally, upon the mapping methods and especially upon the quality of the field survey. The methods of landscape field surveying are still poorly worked out; frequently such surveys are conducted on a low level. It is therefore necessary to pay special attention to the introduction of modern methods of field work and mapping, especially aerial methods. The application of aerial methods makes it possible greatly to speed the work on landscape mapping and at the same time to raise the quality of the maps. Geographers still pay little attention to the methodology of landscape interpretation from aerial photos, and a resolute move must be made in that direction. In particular, landscape scientists should strengthen their ties with the Laboratory of Aerial Methods of the Academy of Sciences of the USSR and organize similar laboratories at the geography faculties.

5. A large circle of questions arises in connection with the practical significance of landscape maps and their introduction into various branches of production and culture. In spite of definite progress in applied landscape mapping, the sphere of practical application of landscape maps is still very narrow. Hence it seems necessary:

(a) to take into account the broad opportunities for the practical use of the landscape map in working out the content of landscape maps and developing a unified type of map; proceeding from this, it is necessary to pay attention not only to the quality of the content, but also to the readability, simplicity and accessibility of the maps; it is especially important to give in the legend or explanatory note, following the example of the authors of certain old maps, a production-oriented interpretation of the natural complexes designated on the map;

(b) to pay more attention to working out applied landscape maps (on the basis of a unified landscape map), bearing in mind the various aims of the national economy, culture, middle and higher education, etc.; along with the development of the above-mentioned trends of applied landscape mapping (evaluation of lands and compilation of a cadaster, landscape-geochemical methods of prospecting for minerals, etc.) it is necessary to study the possibilities of further expansion of the sphere of practical application of landscape mapping (for example, in the planning of cities and resorts, hunting, the conservation of nature, and so forth);

(c) to intensify the popularization of landscape maps, by acquainting the broad masses of the people through concrete examples with the contents, significance and methods of compilation of these maps (in the form of popular brochures, newspaper articles, lectures and readings of papers).

6. Landscape maps at different scales are necessary for science and production. At present, landscape mapping is evolving somewhat one-sidedly: the main attention is being paid to medium-scale mapping; few large-scale maps are being compiled for typical areas and the significance of small-scale maps is especially underestimated. Yet the small-scale landscape map has not only a generally perceptual and educational value, but can also serve as a valuable reference work for economic planning on a nation-wide scale. The small-scale map plays an especially important role as a means of coordinating more detailed work at different scales. It can contribute substantially to tying together regional legends and standardizing symbols, nomenclature and ways of making up medium-and large-scale maps. Hence, it appears quite opportune to pose the question of the compilation of small-scale landscape maps of the various parts of the Soviet Union and the country as a whole. Our experience in compiling a landscape map of all China testifies to the fact that such a project is entirely realistic.

7. Recognizing the necessity of creating landscape maps at different scales, one should especially note the significance of the millionth scale. This scale has been adopted as the basic scale for map series of the USSR geologic and soil maps; there is also a plan for compiling a geobotanic map of the USSR at the same scale. From the viewpoint of landscape mapping the 1:1,000,000 scale must be preferred to larger scales because it would

speed the landscape mapping of the entire country and at the same time permit the morphologic structure of each landscape to be represented with sufficient completeness. The latter circumstance in turn would make it possible to use the landscape map at a scale of 1:1,000,000 as a basis for the physical-geographic regionalization of the Soviet Union.

8. The further development of landscape mapping is being seriously impeded by: the absence of a central scientific institution that could have charge of the scientific-methods direction of landscape mapping and landscape research in general; the small number of qualified landscape-scientists and their slow growth (in number and quality); the extremely limited facilities for publishing landscape maps and scientific-methods research in the field of landscape mapping; the absence of a catalogue and central depository of landscape maps.

To eliminate these deficiencies, it is necessary to carry out definite organizational measures, chief of which are, in our view, the following:

(a) to create under the Academy of Sciences of the USSR and the academies of the union republics special-purpose institutes or departments of landscape science and make it one of the chief purposes of their activity to work out methods of landscape surveying under various geographic conditions and for various purposes and to compile the respective maps;

(b) to add to the educational programs of the universities and teachers colleges in the "Physical Geography" curriculum special courses on "The theory of the landscape," "Landscape mapping" and field practice in landscape surveying;

(c) to establish under the Geographical Society of the USSR a special publication (at first in the form of an Information Bulletin at least), in which research on landscape mapping would be systematically published; furthermore, in the existing publications of the Geographical Society and its branches (Izvestiya VGO, Geograficheskiy sbornik, Voprosy geografii, and the Izvestiya's of the sections), it is necessary to treat more broadly the questions of landscape mapping, including samples of landscape maps;

(d) to entrust the Commission on Landscape Maps under the Presidium of the Geographical Society with organizing a catalogue of landscape maps and conducting an extensive information service on the work being done or already performed through the publications of the Society;

(e) to recommend to all persons and institutions doing work on landscape mapping that they inform the Commission on Landscape Maps regularly about their work and send in reports, copies of maps, legends and other materials.

QUESTIONS OF THE INTEGRATED UTILIZATION OF THE NATURAL RESOURCES OF THE KOMI ASSR

By V. A. Vityazeva

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One of the comparatively little developed economic regions in which an accelerated rate of development of the productive forces is contemplated both in the next few years and in the more remote future, is the economic administrative region of the Komi ASSR.

Being a component part of the major economic-geographic region of the European North, the Komi Republic plays an outstanding role in it. Embracing more than a third of the European North, the Komi ASSR possesses large raw-material and power resources, affording exceptionally favorable possibilities for developing a number of important lines of industrial production.

In the Soviet territorial division of labor the republic represents a great fuel, power and lumber region of the country. Heavy industry furnishes more than 90% of its industrial production. In 1959, the total output of the industry of the Komi economic administrative region exceeded the volume of the prerevolutionary industrial production in this territory by more than a hundred times.

In 1959, 15.3 million cubic meters of lumber were logged in the Komi ASSR, constituting about 4% of total Soviet logging and 33% of that of the European North. In addition 1.6 million cubic meters of sawn materials and 35,500 cubic meters of plywood were turned out.

The total volume of coal production reached 17.5 million tons, of which 11 million were coking coal. The Komi ASSR is now the main fuel base of the European North and Northwest.

The gas and petroleum industries belong to the most important branches of the republic's economy. The Komi ASSR is now the only region producing coal and petroleum products in the North of the European part of the USSR and one of the largest suppliers of carbon black and high-grade asphaltite in the Union.

The most important auxiliary industries are: power, building materials and metalworking. Alongside of these, small enterprises for the production of consumers' goods have also been created: leather, footwear, confectionery, bakery products, etc. The republic's agriculture has a clearly pronounced dairying trend.

The industrial development of the Komi ASSR has been accompanied by a rapid growth in population, the development of cities and workers' settlements. There are now seven cities and over thirty workers' settlements in the republic.

It should be noted that, in spite of the success achieved during the years of Soviet rule, the present level of the Komi economy still does not correspond to the available natural resources. The republic's economy contains a number of non-conformities and disproportions in the development of the several industries, especially the lag of the processing industries behind the extractive industries, and of the auxiliary industries behind the specialized industries, as well as the inadequate development of transportation, especially railroads. Mainly extractive branches of industry are being developed in the Komi ASSR. In 1958 their share was 63.2% of the total value of industrial output. This structure of the industry results in an irrational burdening of transportation and an incomplete utilization of the natural wealth of the republic.

The forest resources are being used irrationally. An analysis of their present use shows that because of the slight development of the wood-processing industry and the complete lack of wood-chemical production only 35 to 40% of the timber earmarked for cutting is being used rationally. Every year about 4 million cubic meters of lumber in the form of logs, boughs, tops, bark, sawdust, etc., are left in the cut-over areas and the lower storage places of the lumber roads; and counting incompletely cut timber, and the inferior grades and firewood that are not hauled out, as well as the waste from sawing and woodworking, the total amount of unused wood reaches 5.5 to 6 million cubic meters (Shakhray, 1958). Millions of cubic meters of petroleum field and refinery gases, representing an efficient raw material for the chemical industry, expecially for the development of the production of high-polymer compounds, are released into the atmosphere or burned in flares. The waste gases of the carbon-black plants are not being used. The low level of integration of the republic's economy cannot contribute to a lowering of the high production costs.

As a result of the poor development of the transportation connections between the republic and the other regions of the country, and particularly the absence of railroad connections with the regions of the Central Urals, about 10 million tons of high-grade Pechora coking coal are burned annually in steam locomotives and electric stations as an ordinary power fuel.

Production of local building materials, wall materials, gypsum and especially such progressive types of building materials as reinforced-concrete articles, blocks, etc., is lagging sharply. It suffices to state that the republic's requirements for wall materials are at present being satisfied only 53%, for cement 22%, and for prefabricated reinforced concrete 18%.

In a number of cases the exploration and preparation for exploitation of mineral deposits lags behind production needs. Nor does the present state of

the power base correspond to the demands of the economy. The small, isolated electric stations no longer meet requirements.

The lag of agriculture behind the demands for food products deserves attention. According to data gathered by the Komi branch of the Academy of Sciences of the USSR, the population's requirements for farm products in 1959 were filled by local production to the extent of 29% for milk and milk products, 16% for vegetables, and 16% for meat and meat products. The population's demands for foodstuffs are being covered mainly by bringing in products from other regions of the country, which sometimes causes difficulties in supplying certain points with fresh and vitamin-rich products.

The existing discrepancies and disproportions in the development of the economy of the Komi ASSR and the resultant incomplete and irrational utilization of the natural resources is to be explained largely by the slight degree to which its natural wealth has been studied. Thus far, a considerable part of the Komi ASSR has not been sufficiently studied with respect to geology, and many questions of petroleum-gas occurrence and the distribution of minerals remain unclear. This retards the organization of new producing plants and the expansion of existing enterprises. The lack of labor resources exercises a substantial influence.

Yet the Komi ASSR has possibilities for the rapid development of the existing branches of the economy and the creation of large industrial complexes of new producing plants.

The further development of the republic's economy must involve the integrated and most rational utilization of the natural wealth with a minimum expenditure of social labor, the industrial exploitation of the highly valuable and deficit minerals, and the elimination of existing disproportions and discrepancies in the development of individual branches of the economy.

In accordance with the resolutions of the 21st party congress, it is necessary above all to organize complete and efficient use of the forest resources. Concentrated in the Komi ASSR is 40% of the forest-covered area of the European North with a total timber reserve of 2.5 billion cubic meters. This is almost as much as in the Vologda, Perm' and Kirov oblasts together. The forests of the Komi ASSR are characterized by predominantly mature stands. The mature and overmature stands occupy 82% of the forest-covered area and over 80% of the reserves. An important feature of the republic's forests is that over 80% of the reserves are conifer stands, chiefly fir, a valuable raw material for the chemical industry. The main task in the development of the Komi lumber industry is to increase the proportion of lumber processing industries. An especially large role should belong to the chemical processing of wood.

Now that the development of chemistry in the USSR has achieved major successes, a large role is assigned to the chemical processing of wood and the waste from logging, sawing and woodworking. Modern wood chemistry

can create the necessary conditions for complete utilization of all forest raw materials and supply the economy with dozens of new products. The following data shows how lumber can be replaced advantageously by the products of its chemical processing: insulating fiberboard 12.5 mm. thick are equal in thermal properties to a wooden panel 40 mm. thick, i.e., one cubic meter of fiberboard, manufactured entirely of wood waste, replaces in construction 3 to 4 cubic meters of sawnwood or 5 to 7 cubic meters of round timber. One cubic meter of chipboard, also manufactured from waste, replaces 2 to 3 cubic meters of sawnwood or 4 to 5 cubic meters of round timber. A still larger economy is effected by using logging waste to manufacture paperboard, a ton of which replaces as much as 10 cubic meters of sawnwood or 15 cubic meters of round timber in packing (Veynov, 1956).

Studies made in recent years by the Komi branch of the Academy of Sciences of the USSR show that under the conditions in the Komi republic the most suitable and economical lines for the chemical processing of lumber and firewood are pulp-and-paper and paperboard production. The volume of lumber that can be processed into board, paper and pulp, with the volume of logging contemplated by the Komi branch of the Academy of Sciences of the USSR for 1975 (28 to 29 million cubic meters) is 7 to 8 million cubic meters. The processing of this amount of wood will permit a yearly output of over a million tons of board and more than 700,000 tons of paper.

The main lines of chemical utilization of logging, sawmill and woodworking waste are: power-chemical production, manufacture of fiberboard and chipboard, as well as rosin, turpentine and hydrolysis products. With the volume of logging, sawing and woodworking that is to be attained in the republic by 1975, about 8 million cubic meters of raw lumber will be used annually for these purposes. This will permit the annual production in the republic of over one million cubic meters of chipboard, 70 to 75 million square meters of fiberboard, and a large quantity of pitch, glucose, albumin yeast, acetic acid, etc.

Syktyvkar, Troitsko-Pechorsk and Pechora should become the most important centers of pulp-and-paper and board production. Estimates show that, as a result of favorable combinations of natural and economic conditions, as well as the presence of cheap natural gas, the cost of one ton of pulp of the Syktyvkar pulp-and-paper mill will be 50 to 60 rubles lower than that from the Kotlas mill. Total economies would be 60 to 70 million rubles a year.

The coal industry should undergo further development in the republic. The Pechora basin is the largest in the European part of the Soviet Union. Its reserves exceed 260 billion tons. A fourth of these reserves is high-grade fatty coal with an insignificant amount of harmful admixtures. Fatty coal is the main constituent of blast-furnace charges. For this reason, the Pechora coal basin should be developed as a basin of blast-furnace fuel. Thus far, the bulk of the coking coal has been used irrationally. In the long term, coal mining may reach 30 to 35 million tons a year, including

23 to 25 million tons of coking coal. The main consumers of Pechora coal may be the steel plants of the Urals, the North and possibly the Center (Vityazeva and Dvorin, 1958). A considerable amount of coal may be exported.

The principal tasks in the coal industry are insurance of the most rational and efficient use of high-grade coking coal and a sharp reduction in the labor and material expenditures for its extraction. Another important task is the continuation of geologic prospecting work in search of new areas with coking coal, situated under favorable mining-geology conditions, and also large coal deposits suitable for open-pit mining.

During the years of Soviet rule, the petroleum and gas industry, important for the economy of the North, has been developed in the Komi ASSR. In the long term, the extraction of petroleum and gas is growing sharply. For this reason, a change is contemplated in the structure of the republic's fuel balance. The share of petroleum and natural gas in the total production of mineral fuel in 1975, according to estimates made by the Komi branch of the Academy of Sciences of the USSR, can be increased to 43%, which will make it possible to bring about a considerable rise in the productivity of social labor.

According to geologists, the probable reserves of petroleum and natural gas in the Komi ASSR are considerable. On this basis, it is right to raise the question not only of expanding the extraction of petroleum and gas, and of increasing the capacity of the oil-refining enterprises, but also of creating a large chemical industry founded on the use of oil-field gas, natural and refinery gases.

The resolutions of the 21st party congress contemplate a major program for the development of the chemical industry. Much attention is devoted to the use of gas as a chemical raw material, especially in connection with the development of high-polymer synthetic materials, destined to furnish additional raw-material resources to increase the output of various products of industry and consumers' goods. In connection with this and with the considerable increase in the extraction of oil and gas, it is advisable to create large enterprises for the production of polyethylene and polypropylene, the most universal and advanced types of plastics.

The production of nitrogen fertilizers for the republic's agriculture and for the nearby regions should also be included in the chemical complex on the basis of the use of waste from carbon-black plants and of nitrogen from the air.

The expected presence of oil and natural gas reserves and the necessity of sharply increasing their extraction renders obligatory the planning of further expansion of the prospecting and exploration work for oil and gas using the latest methods and the latest equipment. The main center of the oil and gas chemical industry should be the Ukhta area, where the

raw-material and fuel resources are best combined; this is favored by the presence of transportation lines, producing capacity and, finally, skilled specialists who have grown up here in the process of formation of the region.

The republic has large reserves of rock and potassium salts. The largest deposit of rock salt is the Seregovo deposit, which has favorable mining-geologic and transportation conditions. Its general reserves are 5.5 billion tons. Rock salt is a raw material for obtaining soda ash and chlorine. Considering that a large amount of bleaching substances is needed for the pulp-and-paper industry to be created in the republic and near-by economic administrative regions, it is advisable to create in the Komi ASSR a large enterprise for producing chlorine and its derivatives. On the basis of the Seregovskoye deposit it is also possible to build a large plant to produce table salt for the needs of the regions of the North and Northwest (Shishkin, 1958). It is advisable to examine the question of the use of potassium salts from the basin of the Upper Pechora, especially if the Ukhta-Solikamsk railroad is built. The salts reserves here exceed 10 billion tons. The potassium salts of the Pechora can be used in conjunction with the production of titanium.

Thus, one of the first-priority problems of the further development of the Komi administrative region is the creation of a large chemical industry.

The further development of the leading branches of the economy requires a corresponding development of power, metalworking and transportation.

The volume and rate of the contemplated construction will depend largely upon the development and improvement of the building-materials industry.

The Komi ASSR possesses large sources of raw materials for the production of building materials; they exist in almost all areas. Considerable deposits of limestone, a fine material for cement production, are located in the regions of Vorkuta and Ukhta. The largest limestone deposit is the Bel'gop deposit. There are deposits of clay, sandstone, gravel, etc. Of great importance is the Izhma gypsum deposit. In the future, it will be necessary to organize the production of wall materials, prefabricated reinforced concrete, cement and other building materials. It is proposed to make wide use of mechanized methods of assembling and erecting buildings and other structures of blocks and factory-made parts. Prefabricated reinforced concrete will be the basis of industrial construction.

The Ukhta region must be regarded as the most promising for the production of building materials in the republic: it has an especially favorable combination of various high-grade mineral and raw-material resources: limestone, clay, silicate sands, etc., with a cheap fuel, natural gas.

The creation of a large chemical industry and the further growth of the capacities of the woodworking and oil-refining industries will radically change the structure of the economy of the republic. One of the leading

branches will be the chemical industry, the share of which may be raised to 15% of the total output of industry. There will be a considerable growth in the share of the woodworking industry with a certain lowering of that of coal mining.

Komi branch of the Academy of Sciences of the USSR.

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THE TEACHING OF CLIMATOLOGICAL SUBJECTS IN THE COURSE IN THE GEOGRAPHY OF THE USSR

By S. I. Zhakov and Ye. Ya. Fedorova

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Climatology and meteorology explain a large circle of important and interesting natural phenomena studied in physical geography courses. Climate is one of the components of the geographic environment. Recent research by Soviet scholars has shown the determining role of climate (heat and moisture) in the main directions of development of the natural complexes and the zonality of nature. Hence, a knowledge of the basic climatic processes and laws is an indispensable premise and an absolute condition for fruitful study of physical geography. An understanding of the laws of climate formation and its characteristics is also necessary for the subsequent study of economic geography, which examines the effect of climate and the geographic environment as a whole on the development and distribution of agricultural production. The study of climate is also of significance for the general education of middle school graduates.

Yet the teaching of climatological questions in the schools is in an

unsatisfactory state. This is due to many causes, and above all to the wrong presentation of climatological material in textbooks.

This article states some views in connection with the drawing up of the new program and the new textbook on the physical geography of the USSR and draws the attention of teachers to the present shortcomings in the teaching of climatological material in this course.

The climatological material in the course on the physical geography of the USSR is studied in two stages: in the general survey and in the characterization of the natural conditions of the regions. In addition to this, the close connection between climate and the other components of the geographic environment requires the use of climatological material in explaining the spatial laws of development of these components and of the whole environment.

Special attention must be paid to the general survey, upon the content and quality of which depends the acquisition by the pupils of basic climatological notions and the mastery of subsequent instruction material of the course. The general survey must show with the necessary thoroughness and explain as clearly as possible the most important climatic laws operating on the territory of the USSR. This creates a good basis for the fruitful study of the remainder of the course. Knowing the basic laws of the distribution of climatic conditions, the pupils will be able, with the teacher's aid, to draw conclusions about the peculiarities resulting from these laws in the climatic conditions of individual regions, and the basic reasons for these peculiarities will also be comprehensible to them. The study of the individual regions may serve to concretize and deepen the general notions already possessed by the students. (A similar approach is, of course, also necessary in studying other components of the geographic environment and in constructing the whole course.) Here the class-discussion method may be widely employed. As a whole, the plan of presentation of the climatological material acquires logic, which is lacking in the existing textbook by K. F. Stroyev (here the climate of each region is described and explained by itself, without any relation to the general laws, which are inadequately shown and not always correctly explained; the general laws in this book did not serve as a clear background against which to bring out the climates of concrete regions).

Thus far characterizations of climates has been practiced in the schools only through average temperatures and total precipitation. Such a characterization is formalistic and does not help the students to understand the essence of the physical-geographic processes in the various natural zones and regions of the country, nor does it train them to evaluate the properties of climate as one of the important natural resources.

It is advisable to characterize climate by its two basic integrated properties: the heat regime and moisture supply. These properties of climate determine the development of the whole geographic environment and exert an enormous influence upon the distribution of agricultural production.

Characterization of the heat regime in the school course in USSR geography should, in our opinion, include: the mean January and July temperatures; the stability of heat conditions and the possible maxima and minima by seasons; the duration of the growing season and its exposure to frosts. It is also necessary to acquaint the pupils with the concept of the sums of mean daily temperatures in the growing period as a means of expressing the heat resources of a territory and to show the basic features of the distribution of the sums of temperatures on the plains and their dependence upon the absolute altitude and relief in mountains and on uplands. This can be done with a small amount of figures if the distribution of the heat resources is shown on a comparative plane and with relation to the heat requirements of some of the most important cultivated plants.

The subject of moisture supply may be begun with an explanation of the concept of "moisture supply." It signifies an area's provision with the water necessary for the development of the natural environment and agricultural production. The source of moisture under natural conditions, with the exception of certain specific and very limited localities (river floodplains, places of issue of ground water and others) is atmospheric precipitation. Hence, the distribution of precipitation over the country's territory and the characteristics of the annual march of precipitation constitute an important part of the content of the subject of moisture supply. However, precipitation, as correctly reflected even in K. F. Stroyev's book, does not determine moisture supply; the latter depends upon the ratio between the amount of precipitation and evaporability. The students must be acquainted with this fact more definitely and clearly than is done at present.

It is very important to show the zonal character of moisture on the plains and its dependence upon altitude and relief in mountains and uplands. This, together with the preceding material on the heat regime, will prepare the students to understand the zonality of nature.

The subject of moisture supply must also cover the questions of the significance of snow cover as a source of moisture for the growing period in zones of insufficient moisture, and questions of drought and methods of combating it.

The introduction of the concepts of the sums of temperatures and moisture supply is necessary not only for a more serious approach to the study of physical-geographic processes, but also in practical respects. As is known, temperature sums and moisture supply now serve as the basis of agroclimatic regionalization and are used in agroclimatic handbooks as the most important indices.

The characterization of the climatic laws on the territory of the USSR should be completed by showing the role of heat and moisture in the development of the geographic environment and in the distribution of agricultural production. This conclusion of the subject of climate in the general survey in the USSR physical geography course will serve as a natural transition

to the study of the material on inland waters, soils, plant cover and natural zones, and will contribute to a better grasp of the interrelationships in nature.

A study of laws and their causes should be the basis of the study of the climatological material (as of all material in the general survey). Only this can insure an understanding of the material studied and can contribute to the development of thought; only this will make it possible to rely on the intellect, not on a mechanical memorizing of miscellaneous information. In this connection, a broadening of the knowledge acquired in the preceding physical-geography courses is needed in the USSR physical-geography course. The introduction of certain new concepts is also unavoidable. However, this accessory material should, in so far as possible, not be placed separately, as is done in K. F. Stroyev's book, but organically tied together with the basic material, thus strengthening the explanatory character of the whole presentation.

The explanation of the climatic laws and phenomena should, of course, be based on modern scientific notions. Let us dwell upon certain very important inaccuracies and errors that are most often committed in the schools.

The role of the west-east transfer of air predominating over the whole of our country is not taken sufficiently into account in a discussion of climate formation. This characteristic feature of the circulation of the troposphere in the temperate latitudes determines the immense influence upon the climate of the USSR of the marine air masses from the Atlantic and the very limited influence of similar air masses from the Pacific. Connected with it is the fact that the severity of the winters and the continentality of the climate do not reach the highest value in the middle longitudes of the continent, but on its eastern margin, in the basins of the Indigirka, Lena and upper Amur, though they lie nearer to the Pacific Ocean than do the western regions of the European part of the USSR, known for their mild climate, to the Atlantic Ocean.

Here it is appropriate to note the traditional exaggeration of the role of the mountains lying along the Seas of Okhotsk and Japan. These mountains, while exerting a definite influence on the circulation, do not represent obstacles to the penetration of Pacific air and cyclones into Siberia. They are neither high enough nor continuous enough to do so. Air and cyclones from the Pacific do not penetrate far into the continent because of the west-east transfer of air prevailing throughout the year and the stationary existence of anticyclones over Siberia in the winter.

Of great importance for climate formation is the circumstance that the cyclonic circulation of the atmosphere weakens greatly from west to east in the cold part of the year, while the anticyclonic circulation becomes stronger. The weaker cyclonic activity in Siberia by comparison with the European territory of the USSR also occurs in the warm part of the year. This is not made clear in the textbook, which gives the concepts of cyclone

and anticyclone, but does not use them to explain the climatic laws. If these phenomena are lost from sight, it is impossible to explain correctly the basic spatial laws of the heat regime and the distribution of precipitation.

Because of the weakening of the cyclonic circulation from west to east the condensation processes weaken in the same direction (connected with them is the release of heat of condensation) and cloudiness diminishes. And the less the cloudiness, the more heat the earth loses through radiation. Thus, the weakening of the cyclonic and the strengthening of the anticyclonic circulation in an easterly direction is one of the basic causes of the increase in the severity of the winters in this direction and the shortening of the frost-free period.

Connected with the activity of the cyclonic circulation is the quantity of precipitation. The textbook and various kinds of teaching aids ignore this, and the universally known law of the diminution of precipitation from west to east is usually explained merely by the fact that moisture is brought to the USSR by air currents from the Atlantic Ocean and is lost in moving over the land, and that the air becomes poorer in water vapor as it moves inland. However, this explanation is correct only for the cold part of the year and even then only with the qualification that a change is also noted in the character of the atmospheric circulation from sharp predominance of the cyclonic in the west of the European territory of the USSR to a mainly anticyclonic circulation in Eastern Siberia and the Far East.

In summer, owing to the great evaporation from the land surface the amount of water vapor does not diminish as the air moves from west to east, and the mean moisture content of the air in Eastern Siberia is not less than in the European part of the USSR, in spite of the great role of arctic air in the formation of local air masses in Siberia. Hence, the diminution of the precipitation from west to east in summer is not due to a "loss of moisture by the air," but is mainly the result of the weakening of the cyclonic circulation in this direction and the rise in vertical stability of the air masses. Here it should be remembered that summer precipitation constitutes the bulk of the precipitation occurring annually over the territory of the USSR.

The predominance of summer precipitation in the USSR is explained in K. F. Stroyev's textbook by the transpiration of the plant cover in spring and summer and by evaporation from the soil. This explanation reflects a certain aspect of the phenomenon, but it cannot be called correct. The summer maximum of precipitation, which falls in the middle of the summer over the larger part of the USSR, is due primarily to the fact that the air is hottest in summer and therefore contains more water vapor than in the other seasons. In the Far East and in Eastern Siberia the summer maximum is extraordinarily intensified by the seasonal character of the cyclonic circulation, which in these regions is well developed only in summer. In the subtropics the precipitation maximum falls in the transitional seasons or in winter, likewise in conjunction with the seasonal character of the cyclonic circulation: it is here more developed in the cold part of the year. The air filling the warm

sectors of the cyclones in the subtropics contains comparatively more water vapor even in the winter, though considerably less than in the summer.

The heat regime of many regions results from the loss of heat to evaporation and the heating of the cold air masses and soil. In the schools, this is usually not taken into account. But without doing so it is impossible to explain correctly the characteristic features of the climates of these regions and the climatic laws operating in the USSR. Thus, the insignificant loss of heat to evaporation in Soviet Central Asia and other arid regions of the country is the cause of the very high summer temperatures, though these regions are not marked by a high radiation balance in summer. The great loss of heat to evaporation and the heating of marine air, relatively cold in summer, produces predominantly cool weather in the west of the Ukraine and in the Ussuri region. The frequent invasions of cold air from the Arctic basin, as well as the loss of heat upon the thawing and heating of the ground, are the cause of the cold summers in the north of the USSR, though the radiation balance in summer here, owing to the long polar day and relatively low effective radiation, is little inferior in size to the radiation balance in Soviet Central Asia.

The examples cited point up serious errors committed at present in the explanation of climatic phenomena and the fact that the new generation is getting false notions from the pages of the textbook about most important natural phenomena. There can be no doubt that an elementary explanation, on a scientific basis, of most of the basic climatic laws operating in the USSR is entirely intelligible to pupils of the 7th and 8th grades. These pupils master equally complex concepts and laws in the courses in mathematics, physics and chemistry. Those phenomena (there should not be many of them) that are included in the course but the explanation of which presents difficulties would be better left unexplained than explained falsely. In any case, we must not follow a course of primitivism and "facilitate" the instruction process at the expense of scientific teaching. The study of a subject is facilitated and made more interesting and meaningful for the pupils by scientific exactness and good, clear explanations, even if they somewhat increase the number of pages in a textbook. The unburdening of pupils should be done at the expense of secondary material.

EKONOMICHESKIYE RAYONY SShA (Economic Regions of the United States) By L. Ya. Ziman. Moscow, Geografgiz, 1959, 542 pp.

Reviewed by M. S. Rozin

(From Izvestiya Akademii Nauk SSSR, seriya geograficheskaya, No. 3, 1960, Pages 144 - 147).

The treatment of questions concerning the economic regions in capitalistic countries presents no small theoretical and practical interest. The appearance of the major work by Prof. L. Ya. Ziman on the economic regions of the chief country of capitalism will undoubtedly be met with approval by the geographic community.

The author of the book, Prof. L. Ya. Ziman, was one of the leading economic geographers of the Soviet Union. He devoted 30 years of his life to the treatment of economic-geography questions. Original methodological investigations in the economic geography of the capitalistic countries occupy a prominent place in his works.

Ziman has devoted much attention to the treatment of questions of economic regionalization of capitalistic countries: in particular, he has worked out schemes of economic regionalization of Japan, France and Germany. His work on the economic regionalization of the United States arouses special interest. (See, for example, such works by Ziman as "Natural limits and boundaries of economic regions" (Voprosy geografii, 1948, No. 8), Prirodnyye resursy SShA i ikh ispol'zovaniye (The natural resources of the United States and their exploitation) (Moscow, Geografgiz, 1954), and "Principal regions of the United States " (Geografiya v shkole, 1956, No. 1).

Ziman's main work, devoted to the economic regions of the United States was not published during his lifetime. Attaching great significance to this great scientific work and counting on its importance for the further treatment of questions concerning the economic geography of capitalistic countries, the commission on the literary legacy of L. Ya. Ziman, created under the Moscow branch of the Geographical Society of the USSR, recommended the publication of this work. V. M. Gokhman and A. G. Mileykovskiy were engaged as editors of the book by the State Publishing House for Geographical Literature at the recommendation of that commission. V. M. Gokhman did the revision of the material and introduced the necessary additions. P. M. Alampiyev, Ye. N. Lukashova and G. M. Ignat'yev lent valuable assistance in working on certain parts of the manuscript.

The book consists of six parts, which can be combined into four sections: (1) General methodological questions of economic regionalization in the capitalistic countries (part I); (2) A characterization of the three principal regions of the United States (part II); (3) A characterization of the economic

regions distinguished by the author within each of the three principal regions (parts III, IV and V); (4) conclusions (part VI).

The author has subjected to a careful analysis the vast amount of concrete material on the course of economic development of the United States and the formation of its economic regions.

Comparing the practice of economic regionalization in the United States and the USSR, Ziman emphasizes a radical difference. He writes: "In contrast to the integrated socialistic regionalization, embracing the whole economy of the country and forming an organic constituent of the planned organization of the whole national economy, economic regionalization in capitalistic countries reflects the dominance of the market element in the economics of these countries" (p. 8).

The author points out the fundamental significance of the doctrine of economic regions in Lenin's classic work, "The development of capitalism in Russia." He also notes the exceptionally great importance, for the treatment of the problem of economic regionalization, of another classic work of Lenin's: "New data on the laws of the development of capitalism in farming."

Emphasizing the historical character of economic regions, the author subjects to criticism the views of a number of American geographers holding the viewpoint of an extra-historical classification of economic regions. After a careful examination of the individual features of an economic region, the author arrives at the following definition: "An economic region is a historically constituted community of territory and economic life manifesting itself in intra-regional and inter-regional economic ties and based on a definite structure of the productive forces and production relationships" (p. 46).

In Ziman's definition we find a number of the main features pointed out in the well-known theses of the commission under the Presidium of the All-Union Central Executive Committee under the chairmanship of M. I. Kalinin on questions of economic regionalization: (a) regionalization is based on the economic principle; (b) the presence of an economically unique territory; (c) emphasis on the role not only of the productive forces, but also of the production relationships; (d) consideration for the inter-regional and intra-regional economic ties.

In characterizing the economic regions of the United States, the author devotes special attention to the historical approach. Subdividing the history of the United States into four periods: (1) from the beginning of the 17th century to the war for independence; (2) from the war for independence to the Civil War (1861-65); (3) from the North's victory over the South to the beginning of the 20th century; (4) the epoch of imperialism, the author analyzes in detail the history of the formation of the three principal regions of the United States which Lenin called the Industrial North, the Former Slave-holding South and the Colonized West.

Speaking of the fourth period, the author rightly notes the increasing struggle between the regions of the United States. The facts concerning the retention by the North of industrial supremacy given in the book (pp. 127-34) sound convincing, though it also takes note of a tendency toward a certain reduction in the North's share due to the growth of industrial production in the South and West.

Nonetheless, it is hard to agree with the author's conclusion that the present-day South and West have persisted as agrarian raw-material borderlands: "In spite of the development of capitalistic industry in the regions of the Former Slaveholding South and Colonized West, they remain primarily agrarian raw-material borderlands" (pp. 67-68). This sort of a formulation is also encountered in other passages of the book. Thus, on p. 108, we read: "But, in spite of the rapid development of industry in the Former Slaveholding South and Colonized West, they remain agrarian raw-material adjuncts of the Industrial North, whose monopolies continue to dominate in the whole economic life of the country." With reference to the South, he says on p. 120: "In spite of the considerable growth of industry during and since the Second World War, the South has remained an industrially backward region, an agrarian raw-material adjunct and supplier of cheap labor."

Such a treatment of the South and West was undoubtedly correct up to the Second World War. But during and especially since the war there have been substantial shifts in the distribution of United States industry. In the South and West are located important enterprises of the new atomic energy industry. The South and West, taken together, predominate in the production of hydroelectric power and in power-consuming lines of production (aluminum, magnesium). These regions play a prominent role in ship and aircraft manufacture, as well as in the chemical (especially petrochemical) industry. Hence, the present South and West can no longer be treated as agrarian raw-material borderlands. To be sure, these regions are backward in the development of such branches of industry as ferrous metallurgy and machine building, which undoubtedly reflects the relatively low level of their economic development compared with the North.

It would be more correct, in our opinion, to say that as a result of the operation of the law of non-uniform development of capitalism there has been a certain leveling of the three principal economic regions of the United States, with the North retaining its leading position. The monopolies of the North are penetrating to an ever greater extent into the economy of the South and West, and are building large enterprises for the modern branches of industry, exploiting the cheaper labor (in the South) and the richer sources of power and mineral raw materials. Under the new conditions the monopolies of the North are applying new forms of warfare to subordinate the economies of the South and West to their interests.

The author is quite right when he points out the substantial differences in the economic development of the South and West: "The economic development of the South is largely determined by the availability of an inexhaustible

reserve of cheap labor, connected with the survivals of slavery. There is none in the West. On the contrary, the West sometimes suffers from a labor shortage, and the wages there are just as high, or even higher than in the East...." (p. 125).

One can also fully agree with the author that the survivals of slavery still strongly affect the economic and political life of the South (p. 110). Hence, the characterization given by Lenin of the sharecropping widespread in the South of the United States fully retains its force: "We have to deal," wrote Lenin, "with something quite different from the tenants in the European cultural, present-day capitalistic sense. They are principally semi-feudal or - what is the same with respect to economy - semi-slave sharecroppers." (V. I. Lenin, Vol. 22, p. 582).

The author is absolutely right when he states that "the economic oppression of a considerable part of the population of the South is matched by its lack of political rights" (p. 112). This applies especially to the negro population, subjected to racial discrimination.

The sixth chapter, devoted to an examination of the boundaries of the chief regions of the United States, occupies a special place in the book. Starting with an analysis of the economic development of the individual states and their economic gravitation, the author comes to the well documented conclusion that the following correction ought to be introduced into the division made by the Bureau of the Census: Maryland and Delaware, included by the Bureau in the South, as well as the northern half of West Virginia, should be classed with the North.

Within each of the principal regions Ziman distinguishes six to eight economic regions; altogether, he distinguishes 20 such regions. Each is characterized according to a uniform scheme, including: (a) the geographic location of the region and its natural resources; (b) the formation of the region and its development; (c) the economic structure of the region and its external ties; (d) the distribution of production in the region and intra-regional ties; (e) the economic centers of the region; (f) a justification of the distinction of the region and its boundaries.

In the industrial North the author distinguishes the following economic regions: New England, the Middle Atlantic region, the Pittsburgh coal and steel region, the Central industrial-agrarian region, the Agrarian Raw-Material borderland of the industrial North (the Middle West) with the regions of Minneapolis-St. Paul, Nebraska, St. Louis and Kansas. This economic regionalization of the industrial North can arouse no particular objections. In the work by the Institute of Geography of the Academy of Sciences of the USSR devoted to the North of the United States (V. M. Andreyeva, V. M. Gokhman, V. P. Kovalevskiy, M. Ye. Polovitskaya, Moscow, 1958), we find the following economic regionalization of the North: New England, Middle Atlantic region, the industrial-agrarian Lake Region, and the agrarian raw-material Northwestern Center.

Comparison of these two versions reveals an absence of fundamental divergences between them. The version adopted in the work of the Institute of Geography comes from a partial enlargement of the economic regions.

There are noticeable divergences in the economic regionalization of the Former Slaveholding South in the book under review and the work by M. Ye. Polovitskaya (Moscow, 1956), devoted to the South. In Ziman's book, the following are distinguished: the Mississippi cotton region; the Southeastern, agrarian-industrial region; the Northeastern Borderland, including the Middle Appalachian Atlantic region and the Left Bank of the Ohio; the Southwest; and Florida. M. Ye. Polovitskaya's book distinguishes: the Old South, the Upper South, the New South and Florida.

While there are certain elements of similarity (for example, the Northeastern Borderland according to Ziman's scheme and the Upper South according to Polovitskaya's scheme), there are also undoubted divergences in the assignment of certain areas to definite regions.

Such divergences in distinguishing economic regions are encountered frequently, in spite of the fact that Soviet authors proceed from actually constituted economic regions in the countries of the capatalistic world. The divergences derive from a different approach to generalization of the facts. Such divergences should serve as a subject of further study.

In the Colonized West the author distinguishes the following economic regions: the Middle Pacific Region, the Southern Pacific Region, the Northern Pacific Region, the Central Eastern Mountain Region, the Central Mountain Region, the Region of the Middle Rio Grande. This version of economic regionalization may be recognized as legitimate, though corrections might be made in certain parts. For example, the separation of Arizona from Utah may arouse doubt, since these states have economically much in common (for example, a high proportion of mining industry). Arizona is assigned by the author to the Southern Pacific Region, and Utah to the Central Mountain Region.

Ziman's profoundly scientific approach to the characterization of economic regions shows itself, among other things, in the attention paid to documenting the delimitation of regions. As an example, one may point out the distinction of a Northern Pacific Region, in which the author includes Oregon and Washington, a large part of Idaho and the western mountainous part of Montana. In explaining the reasons for distinguishing the western part of Montana from its eastern part, the author points out: "The eastern plains part of this state differs in no way from the neighboring Dakotas. Here predominate wheat and cattle farms, which ship their produce eastward to Minneapolis. In the western mountainous part of Montana the mining and metallurgical industry predominates, being economically connected with the industry of Spokane (Washington) and Northern Idaho. The foothill towns are economically connected with the western mountain territory more than with the eastern plains territory. This applies above all to the town of Great Falls, a non-ferrous metallurgy center" (p. 450).

The justifications differ in clarity and logic of construction. Very expressive are the characterizations of towns and cities given in the book, which may serve as models for economic geographers.

The sixth and concluding part ("Some Conclusions") contains a generalization of the economic ties and economic centers of the region and a characterization of the sizes of the economic regions and their boundaries. Of considerable interest in this part is the concrete analysis of the lack of uniformity in the distribution of industrial production. As the author points out, from among the 20 economic regions distinguished by him only 4 are industrial regions acting in inter-regional relations first and foremost as suppliers of industrial articles and buyers of raw materials. Individual branches of industry are considerably developed in still two other regions (11th and 16th). "Agrarian raw-material branches" predominate in the economics of the remaining 14 regions to a greater or lesser degree (p.495). Even in the "most industrial North, industry is distributed very unevenly, and alongside of territories heavily saturated with industry there are extensive areas, principally on its margins, which are the agrarian raw-material surroundings of a basic industrial core" (p. 489). Ziman concludes: "The United States is a great industrial power. But its industry is concentrated in only a few regions, for which the remaining ones, constituting the majority, serve as agrarian raw-material adjuncts. This is the basic principle emerging from a concrete analysis of the economic regionalization of the United States" (p.495).

The author shows equally clearly the results of the capitalistic division of labor, which inevitably leads to antagonistic contradictions between the economic regions. The simple and intelligible language in which the book is written deserves high commendation. To illustrate certain points, the author makes skillful use of quotations from fiction writers (by I. Ehrenburg, I. Ilf and Ye Petrov, J. Steinbeck, and others).

Among the defects to be found in this book, excellent in content and form, should be noted: a certain amount of schematism in the fifth chapter, in which the economic development of the United States in the epoch of imperialism is characterized; the clearly inadequate cartographic make-up, though the author, who was a skilled cartographer, had prepared many interesting economic maps (it is regrettable that these maps have not been retained, the absence of a place-name index, very important for such a geographic study. On p. 4 a misprint has crept in with regard to the date of the author's death (1955 instead of 1956).

On the whole, Ziman's work is a valuable contribution to economic-geographic science. In addition to a serious analysis of the courses of formation and development of the economic regions of the United States, the book throws light on a number of important methodological questions of economic geography and is of great theoretical interest. For Soviet economic geographers, this book may serve as a model for scientific research in the economic regions of the capitalistic countires. Hence, one should welcome the publication of this book by the Geographical Publishing House and the attention it has bestowed on it in preparing it for the press.

MORE SOVIET COMMENTS ABOUT SOVIET GEOGRAPHY

(From Izvestiya Vsesoyuznogo Geograficheskogo Obshchestva, 1960, No. 5, Pages 468-470)

A new geographical journal titled Soviet Geography has started publication in New York. It is published by the American Geographical Society. The aim of the journal is "to acquaint American geographers with the work of their Soviet colleagues," chiefly through publication of translations of articles by Soviet authors. These articles will be selected chiefly from Izvestiya AN SSSR, seriya geograficheskaya, Izvestiya VGO and Voprosy geografii. An attempt will be made to select articles of general and methodological interest rather than on narrow, specialized topics. In addition there will be news notes on the economic development of the USSR and surveys of the Soviet geographical literature.

The journal is to be published monthly (except July and August) and will contain 80 pages per issue. As an exception ("for bibliographical reasons") the first issue was a combined number (No. 1-2, January-February 1960), though with no increase in the number of pages. The content of the first issue shows the type of articles of interest to our American colleagues. It contains translations of the following articles: I. P. Gerasimov, "The present status and aims of Soviet geography," report to the Second Congress of the Geographical Society of the USSR, Izv. AN SSSR, ser. geogr., 1955, No. 3; D. V. Kravchenko, "The work of the Institute of Geography of the Academy of Sciences of the USSR in 1957," Izv. AN SSSR, ser. geogr., 1958, No. 3; E. M. Murzayev, "Results and aims of physical regional geography in the USSR," Izv. AN SSSR, ser. geogr., 1957, No. 5; Ya. D. Zekkel', "On the courses of development and the next tasks of geomorphology," Izv. VGO, 1958, No. 6; S. N. Ryazantsev, "The results and tasks of studies in regional economic geography at the Institute of Geography of the Academy of Sciences of the USSR," Izv. AN SSSR, ser. geogr., 1957, No. 5; Yu. P. Parmuzin, "The zonal character of the cold pole," Izv. VGO, 1958, No. 5; M. I. Pomus, "An experiment in the economic-geographic study of the cities of the USSR," Izv. AN SSSR, ser. geogr., 1958, No. 1; V. V. Pokshishevskiy, "The major economic regions of Brazil," Izv. AN SSSR, ser. geogr., 1958, No. 4; A. V. Sokolov's review of the map of the forests of the USSR, Izv. AN SSSR, ser. geogr., 1958, No. 2.

The issue also contains news notes by Theodore Shabad, the editor of the journal, reporting on the results of fulfillment of the 1959 economic plan of the USSR and the goals of the 1960 plan, and other news items (the development of the sugar industry in the Kuban', and changes in the oblast structure of Uzbekistan). The issue ends with the tables of content of Izv. AN SSSR, 1959, No. 6; Izv. VGO, 1959, No. 6; Voprosy geografii, No. 45, and Geografiya v shkole, 1959, No. 6.

The publication of the new American geographical journal is to be warmly welcomed. N. S. Khrushchev's visit to the United States (in 1959) opened a new phase in the relations between our two great countries. There are now increasing possibilities for contact between scientists of the United States and the USSR and for broader mutual familiarization with the achievements of science and culture. A serious obstacle to this broad mutual familiarization is inadequate knowledge of language. Apparently fewer American geographers are able to read Russian than Soviet geographers English. It is to be hoped that this "language barrier" will be overcome before too long by geographers of the two countries. In the meantime there is a real need for publication of translations of geographic literature.

The new journal enables the broad circles of American geographers to read English versions of the major articles published in Soviet journals and collections of articles, and thus to obtain a better picture than heretofore of the state of geography in the Soviet Union. There is no need to belabor the point that the new American geographical journal thus contributes to a rapprochement between the peoples of the United States and the USSR. Soviet geographers extend to the journal sincere wishes for success in this noble endeavor.

Our review of the first issue of Soviet Geography would be incomplete if we did not mention the quality of translation: careful translation is of first-order importance for proper understanding of any scientific work published in a foreign language. Soviet translations from English are certainly not blameless in this respect, and Soviet translators, editors and publishers gratefully accept corrections of existing inaccuracies.

The author of this review did not attempt to compare the English translation with the Russian original line by line and paragraph by paragraph. However, even cursory reading of the articles in the first issue of Soviet Geography raised some questions and prompted the reader to check the original. And what did he find? He found unfortunately that in some places the translation was far from faultless, either because some sentences had been translated incompletely or because of actual inaccuracies in translation.

I. P. Gerasimov's article may be taken as an illustration. Compared with the other articles, its translation appears to us to have been less successful. Here are examples of how the American translator condensed some parts of I. P. Gerasimov's article:

Original (words omitted in translation are underlined)	Translation
Soviet geographers have studied the heavily ice-covered central parts of the Arctic Ocean by means of various modern technical devices (p. 13).	Soviet geographers have studied the central ice-covered parts of the Arctic Ocean (p.4).

In close conjunction with the accumulation of factual data geographers in our country developed an advanced scientific theory (p.13).	The accumulation of factual data has gone hand in hand with the development of the Soviet theory of geography (p. 4).
A. A. Tillo and his followers with their work raised our cartography to a very high scientific and technical level (p.13-14).	Russian cartographers - A. A. Tillo and his followers - raised Russian cartography to a high technical level (p. 5).
Soviet geographers have successfully continued the development of an advanced theory of their science (p. 14).	Soviet geographers have continued the development of the theory of geography (p. 5).
However, the decisive role in the formation of a truly scientific basis of a modern theory of Soviet geography has been played by the creative mastering by Soviet geographers of the principles of dialectic and historical materialism (p. 14).	However, the decisive role in the formulation of a modern theory of Soviet geography has been played by the use of the principles of dialectic and historical materialism (p. 5).

There is no need to cite additional examples. The preceding examples make it evident that in many cases the translation was incomplete. Similar condensations are found in other articles. In S. N. Ryazantsev's article, we find:

Original	Translation
Nor do we have thus far comprehensive geographic monographs such as have been published in some foreign countries (p. 56).	Nor do we have comprehensive geographic monographs such as have been published abroad (p.34).

Such a method of translation hardly corresponds to the aims stated by the journal. A more precise translation is necessary to acquaint American readers with the work of Soviet authors. The American reader especially is the loser in case of any condensed translation, not to speak of possible complaints on the part of Soviet authors.

In addition to incompleteness of translation there are also cases of serious inaccuracies. Take, for example, the above-cited sentence out of I. P. Gerasimov's article beginning with the words: "In close conjunction with the accumulation of factual data ...". From the context it is evident that this sentence refers not only to the Soviet period, but also to the pre-revolutionary period, in fact especially to the latter. But in translation this is rendered as the development of only the Soviet theory of geography.

The formation of the theory (p. 14) is translated as formulation (p. 5). Areas of new economic development (p. 18) are translated as areas of new agricultural development (p. 11). First place (p. 20) is translated as leading place (p. 11). There are quite a few such inaccuracies in the translation of I. P. Gerasimov's article.

S. N. Ryazantsev wrote in his article: "Three monographs, approximately of the same type as this series, have been issued in the provinces" (p. 56). This is translated as: "Three monographs of this series have been issued in the provinces" (p. 34). In M. I. Pomus' article, the Ishim and Baraba wooded steppes are called steppes (p. 44) although elsewhere in the journal the term "wooded steppe" is translated correctly.

The journal Soviet Geography is headed by an editorial board ("advisory committee") that includes prominent American scholars, including some who know Russian. Among them is Prof. Chauncy D. Harris, who is well known to Soviet geographers. There would appear to be grounds for assuming that such a qualified editorial group could insure both proper selection of articles and a translation of high quality. At any rate, the foundation has been laid for an important, useful project that will undoubtedly bear fruit. -- O. A. Konstantinov.

(The Editor of Soviet Geography, assuming full responsibility for any condensations or inaccuracies of translation, appreciates the detailed comments by O. A. Konstantinov and the spirit in which they were made. Condensed translations have been avoided since the first issue of the journal. In future any excerpted translations will be so identified.)

ARID-ZONE STUDIES IN THE USSR, 1956-60

F. F. Davitaya

(A summary prepared in English in January 1960 for the annual report of the Arid Zone Commission of the International Geographical Union, of which Dr. Davitaya is a member. Only a very brief condensation of this summary was published in the Arid Zone Commission report in IGU Newsletter, 1960, No. 1. The unabridged summary was made available by Peveril Meigs, chairman of the Arid Zone Commission, and is here presented in full.)

The preparation of the two-volume Climatological Atlas of the USSR is considered the most important project. A prospectus of the atlas was published in 1958. The atlas will contain climatological characteristics of the entire territory of the USSR, including its arid zones.

The atlas contains a series of maps for air temperature, soil temperature, precipitation, evaporation and evaporability, snow cover, absolute and relative air humidity, cloudiness, sunshine, atmospheric phenomena (thunderstorms,

hail, glare and others) and other climatic characteristics, more than 400 maps in all . The atlas is being prepared under the guidance of an editorial board consisting of the following members: F. F. Davitaya (editor in chief), M. I. Budyko (assistant chief), V. P. Pastukh (executive editor), O. A. Drozdov, Ye. S. Rubinshteyn, I. A. Gol'tsberg, T. V. Pokrovskaya, A. N. Lebedev, L. G. Konukhova, P. I. Bondarenko. The first volume of the atlas is scheduled to appear in 1960, the second in 1961.

Much work has been done in preparing agroclimatological guidebooks for the main agricultural regions of the Soviet Union. More than sixty such guidebooks were published in 1956-59 for arid zones. In addition to general climatological characteristics, these books contain data on optimal and extreme dates of planting, phenological phase dates, water supply for plants in different stages of development, the probability of droughts, frosts and other agroclimatological characteristics.

Much work has been done in studying the geographical regularity of soil formation processes in the course of completion and revision of the soil map of the USSR (I. P. Gerasimov, N. N. Rozov, Ye. V. Lobova) and the world soils map (I. P. Gerasimov).

Two volumes of explanatory text accompanying the geobotanical map of the USSR at 1:4,000,000 and titled "The Plant Cover of the USSR" (edited by Ye. M. Lavrenko and V. B. Sochava) were published in 1956. This explanatory text gives detailed characteristics of the plant cover of the USSR, particularly its arid zones. "The Heat Balance of the Earth's Surface" by M. I. Budyko was published the same year. This study represents in particular a theoretical basis for computing evaporation and evaporability in arid areas as well as for computing heat-balance components.

A collection of articles titled "Dry Winds, Their Origin and Protection Against Them" (B. L. Dzerdzeyevskiy, editor) was published in 1957. This publication contains 25 papers summarizing dry-wind (sukhovey) studies in the arid zone of the USSR. The following year appeared an important publication, "Droughts in the USSR, Their Origin, Frequency and Influence on the Harvest" (A. Ya. Rudenko, editor). It includes and summarizes a great deal of material on the distribution of droughts in the USSR, their frequency in various natural zones and on the variations in grain-crop yields over the past century. A collection of articles titled "Problems of Agroclimatological Regionalization of the USSR" (F. F. Davitaya and A. M. Shul'gin, editors), published in 1958, illustrates agroclimato logical resources of arid areas. Many studies on surface-water resources were carried on in the virgin lands of the USSR. The first volume of these studies, on Akmolinsk Oblast, appeared in 1958. The second, third and fourth volumes, on Kustanay, Kokchetav and Pavlodar oblasts (V. A. Uryvayev, editor), were published in 1959. These volumes contain detailed characteristics of the snow cover, runoff and its annual distribution, the regime of streams and of lakes without outflow, and the chemical composition of surface waters. A large monograph prepared by a

group of authors is "Middle Asia, a Physical-Geographic Characteristic" (Ye. M. Murzayev, S. U. Geller, A. N. Rozanov, Ye. P. Korovin, L. Ye. Rodin, N. I. Rubtsov, A. N. Formozov, R. P. Zimina).

Research on soil erosion and the development of soil-conservation methods was published in a collection of articles "Soil Erosion and Soil Conservation" (1958), edited by S. S. Sobolev.

Among the most important studies we should mention experimental research carried on at one of the field stations of the Academy of Sciences USSR. The results of that research were published in a collection of articles "The Scientific Bases for Reclamation of Semi-Desert in the Northwestern Region Adjoining the Caspian Sea" (1958), edited by V. N. Sukachev and A. A. Rode.

Attention should also be given to a monograph prepared by a group of authors and titled "Tectonic Structure and the History of Development of the Caspian Sea Depression and Adjacent Areas in Connection with Problems of Oil and Gas-Bearing Capacity."

In 1957 and 1958 the results of studies carried out under the direction of F. F. Davitaya were presented to sessions of the All-Union Academy of Agricultural Sciences in the form of two summarized reports: "Natural Climatological Conditions and Differentiated Management of Agriculture" (Proceedings of the Anniversary Session of the All-Union Academy of Agricultural Sciences) and "Droughts in the USSR and Scientific Bases for Methods of Combating Them in Various Natural Zones of the USSR" (Proceedings of the Saratov Session of the All-Union Academy of Agricultural Sciences).

An interesting book, "Local Waters in the Desert and Problems of Utilization" by B. N. Kunin appeared in 1959. It illustrates the problem of using atmospheric precipitation through collection and storage in underground reservoirs as well as using fresh ground water widely available in desert areas.

The above-mentioned studies deal with certain components of the physical environment of arid zones. The general theoretical principles of interaction between the lithosphere, biosphere, hydrosphere and atmosphere as well as regularities in the exchange of matter and energy in the geographical envelope of the earth are set forth in a number of studies by A. A. Grigor'yev, published before and after the 18th International Geographical Congress.

In addition to the above-mentioned studies and publications, a large number of physical-geographic studies of arid zones were carried on in the USSR. The results of these studies are set forth in articles, pamphlets and books, including some by F. F. Davitaya. A complete summary of their contents would go beyond the scope of this article. Therefore we have noted only certain studies, which however do not exhaust the list of even the most important and largest investigations.

ON "ENVIRONMENTALISM" AND "POSSIBILISM"

Yu. G. Saushkin

(From Vestnik Moskovskogo Universiteta, seriya geografiya, 1960, No. 3, Pages 67-69)

The journal Izvestiya Akademii Nauk SSSR, seriya geograficheskaya, 1960, No. 1, contained excerpts from a report by the National Committee of Soviet Geographers to the Third Congress of the Geographical Society USSR, titled "The development of international scientific contacts and their importance for progress of Soviet geography" (see Soviet Geography, May 1960, Pages 76-84).

The report noted that there was a serious ideological crisis in modern bourgeois geography, a point of view with which one cannot but agree. But unfortunately the authors of the report committed a regrettable error when, in criticizing geographical determinism, they asserted that it was evident in American work in the form of "environmentalism" and "possibilism." Actually "environmentalism" and "possibilism" are directly opposite trends in bourgeois geography, mutually exclusive of one another.

"Environmentalism" is a modern geographical determinism that considers the phenomena of social life to be a result of the influence of the environment. The most extreme form of "environmentalism" can be found in the work of E. Huntington, who related differences in the "energy of nations" and in the level of "civilization" to climatic characteristics, and economic crises, revolutions, migrations, and rises or declines in the life of various countries to climatic cycles.

"Environmentalism" has been so compromised that it is now being supported openly by very few geographers. American Geography, Inventory and Prospect made very unflattering references to Huntington's work. The American compendium made the point that he "very often combined non-comparable phenomena" and "frequently selected only those data that corresponded to his theory while rejecting findings that contradicted it" (American Geography, Inventory and Prospect , Russian translation, p. 450).

As a reaction to "environmentalism" arose an opposite trend in bourgeois geography, namely "possibilism." It maintains essentially that nature offers society certain possibilities and that society decides when and how, in which direction and in which measure these possibilities are to be utilized. Nature is thus only an object for exploitation; man comes and takes whatever he needs. There can be no question here of any geographical determinism; "possibilism" completely rejects the idea of determinism in relations between nature and society and can be regarded only as a form of indeterminism.

At first glance"possibilism" would appear to be a "progressive" school of thought. The idea that geographers should be interested in nature

only from the point of view of the possibilities that it offers to the economy is rather widely held among Soviet economists. Actually "possibilism" is just as incompatible with Marxism as is "environmentalism."

In the long process of his struggle with nature, man has changed the appearance of nature and has thus acquired special new qualities that differentiate him from the rest of organic nature. Therefore relations between man and nature are not at all similar to relations between exploiter and exploited, as the followers of "possibilism" maintain. In the capitalist world it frequently happens that bourgeois scientists try to apply the social relationships of their system, based on exploitation, to natural phenomena; hence the idea of geographical "possibilism."

Relations between man and nature cannot be the same as those between exploiter and exploited. Man in his activity can operate only as nature itself operates -- he can only change the form of matter. In changing the form of matter during the production process, man always uses the laws of nature, the "gratuitous forces" of nature, its supply of energy.

From the point of view of both "environmentalism" and "possibilism" we could not, for example, understand Marx' key notion that "the need for social control of a force of nature in the interest of the economy, the need to make use of it or to subordinate it by means of large-scale structures built by man has played a decisive role in the history of industry" (italics mine -- Yu. S.) (K. Marx, Kapital, Vol. 1, 1951, p. 517).

The need for social control over the forces of nature acquires special importance in a Socialist society and even more so in the period of construction of communism, when unprecedentedly "large-scale structures" are being built, determining the further development of industry. G. M. Krzhizhanovskiy has beautifully explained the meaning of Marx' idea for his contemporaries: "Out of all the gratuitous forces of nature, the most decisive at any given stage are those that require a great expenditure of labor rather than those that are supplied in finished form by nature's laboratory. A capacity for work and a supply of energy are the real measure of culture" (G. M. Krzhizhanovskiy, Izbrannoye (Selected Works), 1957, p. 449).

Of the many advantages of a Socialist system, we should also mention the fact that it is able to control the "gratuitous forces" of nature by means of "large-scale structures" without interference from private enterprise and unhampered by the contradictions of capitalist development. "There can be no doubt that under such conditions social production actually starts to rival in capacity the gratuitous forces of nature," said Krzhizhanovskiy (op. cit., p. 450).

The following words of Krzhizhanovskiy are directed precisely at the Socialist system: "Man is the most harmonious offspring of nature; work is not a heavy burden for him, but rather a natural need for the full development of his organism" (op. cit., p. 453). The huge structures by means of which Socialist society controls the forces of nature and the large industrial projects built on

sites of natural raw materials, fuels, building materials and hydropower -- all this not only affects the course of development of the economy but gives a great impetus to the chief productive force of society, namely man, by imbuing him with new habits in the struggle against nature, providing him with an immeasurably broader outlook and many other new qualities.

The interrelation and commensurability of productive and natural processes under socialism, and especially in the future under communism, create a new basis for the organic ties and interpenetration of the natural, social and technical sciences. Marxist theory and the practice of Socialist construction also provide a real basis for the unity of the geographic sciences, some of which are natural, others social, and still others technical sciences.

None of the modern theories of bourgeois geography, whether "environmentalism," "possibilism," the chorological concept, or the mathematical method, can provide a basis for the geographical synthesis that all agree is the essence of geography. A striving toward that synthesis, toward an "integration" of studied phenomena, toward an explanation of complex interrelationships between natural, social, technical-economic and other phenomena is inherent in all real geographers, no matter where they live or work.

The deep crisis in bourgeois geographic theories, which are unable to provide a basis for really scientific and practically significant methods of synthesis and for organic ties and an interpenetration of the various geographic sciences, therefore forces the genuine scientists of capitalist countries to pay attention to what is being done in the field of geographic synthesis in the Socialist countries, especially the Soviet Union. Statements by Soviet geographers on questions of geographic synthesis have considerable positive significance. The same is true of the favorable reaction that they provoke among some capitalist geographers.

Differences between bourgeois and Socialist geography do not lie in the fact that bourgeois geography prefers "monism" and Soviet geography a sharp "segregation" of the geographic sciences. On the contrary, the latest summary presentations of American, French and other geographers show that bourgeois geography also sharply differentiates specialized disciplines, thus departing further and further from the idea of "monism." If, for example, United States geographers favor "monism," it is only in forewords and introductions to summary presentations and not in actual practice.

It is only in the Socialist countries, especially in the Soviet Union, that a theory and practice based on the Marxist-Leninist principles of dialectic materialism make it possible to realize geographic synthesis in a new, practical, purposeful way. Such synthesis requires a unity of the system of differentiated geographic sciences, but it is a "monism" of a special kind, of an entirely new type. It is toward such a new unity of geography, based on the principles of Marxist dialectic, that Soviet geographers should strive in every way. Progress in that direction would play a major role in the development of world science.

NEWS NOTES

By Theodore Shabad

New Virgin Lands Kray. An unusual administrative division was established in December 1960 in the virgin lands of northern Kazakhstan. It is the Tselinnyy Kray (Virgin Lands Kray), with its capital at Akmolinsk. The new kray contains the oblasts of Akmolinsk, Kokchetav, Kustanay, Pavlodar and North Kazakhstan. All except Akmolinsk Oblast are retained as administrative units under the jurisdiction of the kray. The Akmolinsk Oblast has been abolished and its rayons have been placed directly under the kray administration. A special administrative set-up for northern Kazakhstan, which differs markedly from the rest of the republic in population distribution (predominantly Russian and Ukrainian) and economy (predominantly grain agriculture), was foreshadowed earlier in 1960 by the establishment of a separate State Farms Ministry (Soviet Geography, April 1960, p. 86) and a separate party organization (Soviet Geography, October 1960, p. 79). The establishment of a kray as an intermediate administrative unit between republic and oblast is unusual in recent Soviet administrative practice, although it was common in the 1930's. The most recent examples of the oblast-kray-republic structure were the Maritime (Primorskiy) Kray, which has had no intra-kray oblasts since 1943, and the Khabarovsk Kray, hose last intra-kray oblast (Lower Amur) was abolished in 1956 (Pravda, December 27, 1960).

Crimean Trolley-Bus Services. An interurban trolley-bus service is being developed in the Crimea to serve the resorts along the Black Sea coast. The Simferopol'-Alushta line across the Crimean Mountains has been in operation since November 1959. The Yalta-Gurzuf section was opened in November 1960, and, with the completion of the Alushta-Gurzuf section early in 1961, service will be possible between Simferopol' and Yalta. Plans call for completion of a trolley-bus ring from Yalta through Sevastopol' to Simferopol' (Ekonomicheskaya Gazeta, November 17, 1960).

Murmansk-Pechenga Railroad Opens. A new railroad linking Murmansk with the Pechenga area was formally inaugurated in December 1960 (Sovetskaya Rossiya, December 4, 1960; Pravda , December 7, 1960). Branching off at Vykhodnoy station south of Murmansk, the railroad goes northwest to Luostari, the icefree port of Pechenga, the old nickel mine at Nikel', and the new copper-nickel surface mine at Zapolyarnyy (Zhdanovskaya railroad station).

Sevan Railroad Completed. The railroad from Yerevan to Lake Sevan in Armenia, under construction since 1955, has been completed (Kommunist, November 29, 1960). It serves the hydroelectric stations along the Razdan (Zanga) River and the prospective nephelite-alumina industry at the town of Razdan (formerly Akhta). The Sevan railroad is to be extended to Dilizhan, Idzhevan and Akstafa, where it would join the main Transcaucasian line from Tbilisi to Baku.

Omsk-Karasuk Railroad Opens. The Omsk-Irtyshskoye line along the Irtysh River and the Irtyshskoye-Karasuk line were opened in December 1960 (Pravda, December 4 and 28, 1960). They are part of the Middle Siberian Railroad system running parallel to and south of the Trans-Siberian Railroad between Kustanay and Barnaul. The Middle Siberian system serves the newly developed virgin lands of northern Kazakhstan and western Siberia.

Other Railroad Construction. The Aktogay-Druzhba line, linking the Turksib Railroad with the Chinese border, opened for traffic in December 1960 (Sovetskaya Rossiya, December 9, 1960). The railroad, passing through the Dzungarian Gate, is part of a new Central Asian railroad link between the Soviet Union and China. The Kursk-Belgorod railroad has been electrified, thus completing electrification of the entire Moscow-Donbas line as far as Slavyansk (Ekonomicheskaya Gazeta, Dec. 9, 1960; Sovetskaya Rossiya, Dec. 9, 1960). Work is proceeding on electrification of the Slavyansk-Ilovaysk section in the Donets Basin itself. Completion of the Kakhovka-Snigirevka railroad in the southern Ukraine in December 1960 (Izvestiya, Dec. 2, 1960) established a direct line from the Donets Basin through Volnovakha, Bol'shoy Tokmak, Fedorovka, Kakhovka, Snigirevka to Nikolayev.

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